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Feasibility Study Report
For
Operable Unit 1
Vasquez Boulevard/Interstate 70
Superfund Site
Denver, Colorado

MFG, Inc.
consulting scientists and engineers

FEASIBILITY STUDY REPORT
FOR
OPERABLE UNIT 1
VASQUEZ BOULEVARD/INTERSTATE 70
SUPERFUND SITE
DENVER, COLORADO

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APPROVAL PAGE

This feasibility study has been prepared in accord with USEPA national and regional guidelines and is approved for release without condition.

USEPA Remedial Project Manager
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Nov 1, 2001
Date

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LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
COCs	Contaminant of Concern
CT	Central Tendency
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
FS	Feasibility Study
GRA	General Response Action
IEUBK	Integrated Exposure, Uptake, and Biokinetic Model
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PRG	Preliminary Remediation Goal
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SIP	State Implementation Plan
TBC	To Be Considered
USEPA	United States Environmental Protection Agency
VB/I70	Vasquez Boulevard and I-70
XRF	X-ray fluorescence

EXECUTIVE SUMMARY

INTRODUCTION

This document presents the Feasibility Study (FS) for the Off-Facility Soils Operable Unit of the Vasquez Boulevard and Interstate 70 (VB/I70) Superfund Site located in the north-central section of Denver, Colorado. The purpose of the FS is to identify and evaluate a range of remedial alternatives to address human health concerns associated with potential exposure to contaminated soils and homegrown vegetables in residential yards. This FS has been prepared in accordance with EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9355.3-01, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.

The VB/I70 site covers an area of approximately four square miles in north-central Denver, Colorado. For the purpose of investigation and remedy development, the site has been divided into 3 operable units (OUs). The residential soils evaluated in this report are known as the Off-Facility Soils Operable Unit 1 (OU1) portion of the site. The locations of the former Omaha & Grant Smelter and Argo Smelter are identified as On-Facility Soils OU2 and OU3, respectively. The site is composed of a number of neighborhoods that are largely residential, including Swansea/Elyria, Clayton, Cole, and portions of Globeville. Most residences at the site are single-family dwellings, but there are also some multi-family homes and apartment buildings. There are approximately 4,000 residential properties within the site boundaries. The site also contains a number of schools, parks, and playgrounds, as well as commercial and industrial properties.

The site came to the attention of the U.S. Environmental Protection Agency (USEPA) following studies directed by the Colorado Department of Public Health and Environment (CDPHE) at the nearby Globe Smelter. These studies had identified elevated concentrations of arsenic and/or lead in residential yards within Globeville, and also extending into the Elyria and Swansea neighborhoods.

The USEPA Emergency Response Program conducted two removal assessment-sampling programs, known as Phase I and Phase II, at residential properties within the VB/I70 study area during 1998. The sampling results at 18 properties warranted time critical soil removal based on surface soil concentrations exceeding 450 mg/Kg arsenic or 2,000 mg/Kg lead.

Based on the Phase I and Phase II results, the USEPA determined that residential properties within the VB/I70 site contained soils with arsenic or lead at levels that could present human health concerns over long-term exposures. On this basis, the site was proposed for listing and was added to the National Priorities List (NPL) on July 22, 1999.

SUMMARY OF REMEDIAL INVESTIGATION FINDINGS

A study and two additional investigations were performed between 1998 and 2000 in support of the Baseline Human Health Risk Assessment:

- Physico-Chemical Characterization Study
- Residential Risk Based Sampling Investigation
- Phase III Field Investigation

Data generated from these investigations are reported in the Remedial Investigation (RI) report, which was issued in final form in July 2001. The Baseline Human Health Risk Assessment was also issued in final form in July 2001. Key RI and risk assessment findings with respect to the development of and evaluation remedial alternatives for VB/I70 OU1 are as follows:

- Generally, metals concentrations are highest in the first two inches of soil and decrease with depth.
- Ninety-one percent of the properties contain mean lead concentrations below the EPA screening level for lead in soil of 400 mg/Kg.

- It is estimated that background levels of arsenic are well-characterized as a lognormal distribution with a mean of 8 mg/Kg and a standard deviation of 3.6 mg/Kg. Based on this, background levels may range up to about 15 mg/Kg or slightly higher.

- Lead levels in bulk soils range from below the detection limit (about 52 mg/Kg) up to a maximum of more than 1,000 mg/Kg. If it is assumed that the upper range of lead concentrations resulting from natural and area-wide anthropogenic sources is about 400 mg/Kg, then the mean of all samples that are less than 400 mg/Kg is about 195 mg/Kg.

- There is only a weak correlation between the occurrence of elevated lead and elevated arsenic in soil, suggesting that the main sources of lead and the main sources of arsenic in yard soil are not likely to be the same.

- Some residential properties contain arsenic at concentrations substantially higher than the expected natural levels. Properties with elevated levels of arsenic occur at widely scattered locations across the site with no clear spatial pattern. At an affected property, the contamination appears to be distributed across the yard area, with a fairly clear boundary between the affected property and the adjacent property. The chemical form of arsenic is predominantly arsenic trioxide.

- Lead also occurs at elevated levels in soil at some residential properties. Elevations occur in all neighborhoods of the site, but levels tend to be higher on the western part of the site than the eastern part.

- Lead was detected in paint at most locations where paint was sampled, with 130 out of 144 samples having values above 1 mg/cm^2. These data suggest that interior and/or exterior leaded paint might be a source of lead exposure in area children, either directly (by paint chip ingestion), or indirectly (by ingestion of dust or soil containing paint chips).

- Using EPA's IEUBK model to evaluate the risk to children, it is estimated that about 45% of residences have levels that exceed USEPA's health-based goal (no more than a 5% chance that a child will have a blood lead value above 10 μg/dL). Of these, many (about 71%) have mean lead concentrations lower than 400 ppm (the USEPA screening level for lead in soil). This is mainly because the site-specific relative bioavailability for lead (84%) is higher than the default value (60%). In order to help determine whether the IEUBK model is yielding reliable predictions at the VB/I70 site, USEPA compared the IEUBK model predictions to actual observations of blood lead levels in the population of children currently living at the site. Even though the available data are from studies that were not designed to support risk assessment, they do support the following:

A. Elevated blood lead levels occur in children residing within the site.
B. Soil is not likely to be the main source of elevated blood lead levels.
C. Elevations are not clearly different from areas outside VB/I70.

In order to investigate the uncertainty of the IEUBK model predictions, USEPA performed alternate IEUBK modeling by revising the model parameters using newly published data. Using the most-recent data available on soil intake rates by children measured during a study by Stanek and Calabrese, the IEUBK model predicts that there are no residences where USEPA's health based goal will be exceeded.

- Mean arsenic concentrations in surface soils in schools and parks range from below the method detection limit of 11 mg/Kg to 26 mg/Kg. The mean lead concentrations range from 67 to 256 mg/Kg.

- In some cases, levels of arsenic in yard soil are sufficiently elevated to pose a reasonable maximum exposure (RME) excess lifetime cancer risk above a level of 1E-04. Based on current data, about 3 percent of all properties fall into this category. Monte Carlo modeling performed as part of the uncertainty analysis in the Baseline Human Health Risk Assessment indicates that the RME point estimate is located at or above the 99^{th} percentile of the probability distribution of risk. Non-cancer risks from chronic or sub-chronic RME exposures to arsenic are also above a level of human health concern at some properties. All of these properties are also predicted to have RME cancer risks above 1E-04.

- Screening level calculations suggest that high level intake of soil associated with pica behavior in children might be of acute non-cancer concern at a large number of properties at the site. Because data are so sparse on the actual magnitude and frequency of soil pica behavior, and considering that discussions continue to occur nationally on the most appropriate acute Reference Dose (RfD) for arsenic, it is difficult to judge which (if any) of these properties should be considered to be an authentic acute health risk to children. In this regard, it should be noted that even though many people are exposed to arsenic levels in soils that are predicted to be of acute concern, both within the VB/I70 site and elsewhere across the country and around the world, to the best of USEPA's knowledge, there has never been a single case of acute arsenic toxicity reported in humans that was attributable to arsenic in soil. Thus, these results for the acute pica scenario are considered to be especially uncertain, since they predict a very substantial risk for which there is no corroborating medical or epidemiological evidence.

REMEDIAL ACTION OBJECTIVES

The overall Remedial Action Objective (RAO) is to protect human health. Based on the findings of the risk assessment, the exposure pathways of concern for residents in VB/I70 OU1 are incidental ingestion of soil and dust in and about the home and yard, and ingestion of home-grown vegetables. The contaminants of concern are arsenic and lead. The following are the RAOs for OU1:

RAOs for Arsenic in Soil

A. For residents of the VB/I70 site, prevent exposure to soil containing arsenic in levels predicted to result in an excess lifetime cancer risk associated with ingestion of soil and ingestion of home grown garden vegetables which exceeds 1×10^{-4} using reasonable maximum exposure assumptions.

B. For residents of the VB/I70 site, prevent exposure to soil containing arsenic in levels predicted to result in a chronic or sub-chronic hazard quotient associated with ingestion of soil and ingestion of home grown garden vegetables which exceeds 1 using reasonable maximum exposure assumptions.

C. For children with pica behavior who reside in the VB/I70 site, reduce the potential for exposures to arsenic in soil that result in acute effects.

RAO for Lead in Soil

D. Limit exposure to lead in soil such that no more than 5 percent of young children (72 months or younger) who live within the VB/I70 site are at risk for blood lead levels higher than 10 ug/dL from such exposure.

This objective is consistent with EPA's guidance that EPA should "...limit exposure to soil lead levels such that a typical child or group of similarly exposed children would have an estimated risk of no more than 5 percent of exceeding the 10 ug/dL blood lead level."

Preliminary Remediation Goals (PRGs) were established based on the evaluation and findings of the Baseline Human Health Risk Assessment. PRGs are contaminant levels in soils that are protective of human health for the various exposure scenarios. The PRGs were set at background concentrations for both lead and arsenic. It is estimated that background levels of arsenic are well-characterized as a lognormal distribution with a mean of 8 mg/Kg and a standard deviation of 3.6 mg/Kg. Based on this, background levels may range up to about 15 mg/Kg or slightly higher. Lifetime cancer risk associated with exposure to background concentrations of arsenic are approximately $1x10^{-5}$. Lead levels in bulk soils range from below the detection limit (about 52 mg/Kg) up to a maximum of more than 1,000 mg/Kg. If it is assumed that the upper range of lead concentrations resulting from natural and area-wide anthropogenic sources is about 400 mg/Kg, then the mean of all samples that are less than 400 mg/Kg is about 195 mg/Kg.

In addition to these PRGs, EPA has established Preliminary Action Levels in this FS. These are exposure point concentrations (EPCs) above which some remedial action is warranted. An EPC is a conservative estimate of the mean concentration within an individual yard. These action levels are: (1) an EPC of 47 mg/Kg arsenic, which is the level at which the Baseline Human Health Risk Assessment predicts the RME acute non-cancer Hazard Quotient is greater than 1 for the Case 2 pica scenario; (2) an EPC of 240 mg/Kg arsenic, which is the level at which the Baseline Human Health Risk Assessment predicts RME lifetime cancer risks exceed 10^{-4}; (3) an EPC of 208 mg/Kg lead, which equates to a less than 5% chance that any child will have a blood lead value above 10 ug/dL based on the IEUBK model adjusted by using site-specific data on the levels of lead in house dust and the relative bioavailability of lead in site soils; and (4) an EPC of 540 mg/Kg lead, which also equates to a less than 5% chance that any child will have a blood lead value above 10 ug/dl based on an alternate IEUBK model run (see Appendix C). These concentrations equate to the EPCs used in the Baseline Human Health Risk Assessment and any evaluation of concentrations of lead or arsenic in residential yard soils must use the same sampling methodology as the RI and same evaluation methodology as the risk assessment to provide comparable results.

DEVELOPMENT OF REMEDIAL ALTERNATIVES

Based on site conditions and RAOs, a range of General Response Actions (GRAs) were identified. GRAs are general categories of remedial activities (e.g. no action, institutional controls, containment, etc.) that may be taken, either singly or in combination, to satisfy the requirements of the RAOs. Remedial technologies and process options are more specific applications of the GRAs. Remedial technologies and process options were identified for each GRA and screened in accordance with procedures described in RI/FS guidance. In the first screening step, remedial technologies that have limited or no potential for implementation at the site were eliminated. Remedial technologies and process options that passed the initial screening test were then subjected to a second, more rigorous, screening evaluation of their anticipated effectiveness, potential implementability and relative cost. The remedial technologies and process options that survived the screening were carried forward for consideration in the development of remedial alternatives.

Based on this process, five remedial alternatives were identified as follows:

- Alternative 1 - No Action
- Alternative 2 – Community Health Program, Tilling/Treatment (Lead), Targeted Removal and Disposal (Arsenic)
- Alternative 3 – Community Health Program, Targeted Removal and Disposal
- Alternative 4 – Community Health Program, Expanded Removal and Disposal
- Alternative 5 – Removal and Disposal

Detailed descriptions of the alternatives are provided below.

Alternative 1 - No Action

The no action alternative provides a baseline for the evaluation of other alternatives in accordance with the NCP. No additional protective or remediation measures would be taken for the no-action option. Soils have already been removed from 48 residential properties at the site.

In general, the no-action alternative may be viable if constituent concentrations are below remedial action levels. This alternative may also be appropriate for materials or soils which do not pose unacceptable risks to human health or the environment, if implementation of remedial actions would create a greater risk, or if the cost of remediation is excessive when compared to the risk reduction.

Alternative 2 – Community Health Program, Tilling/Treatment (Lead), Targeted Removal and Disposal (Arsenic)

Alternative 2 contains the following principal components:

- Implementation of a community health program.

The community health program alternative for the VBI70 site would be composed of two separate (but partially overlapping) elements: the first designed to address risks to area children from lead in un-remediated soils above the preliminary action level of 208 mg/Kg; and the second designed to address risks to area children from pica ingestion of arsenic in un-remediated soil above the preliminary action level of 47 mg/Kg. Each of these two main elements of the program is described below. Participation in one or both elements of the program would be strictly voluntary, and there would be no charge to eligible residents and property owners for any of the services offered by the community health program.

PUBLIC HEALTH PROGRAM TO REDUCE RISKS FROM LEAD

The program for reduction of lead risks is intended to be general. That is, it is intended to assess risks from lead from any and all potential sources of exposure, with response actions tailored to address the different types of exposure source which may be identified. The lead program will consist of three main elements:

1) Community and individual education about potential pathways of exposure to lead, and the potential health consequences of excessive lead exposure.

2) A biomonitoring program by which any child (up to 72 months old) may be tested to evaluate actual exposure.

3) A program to respond to any observed lead exposures that are outside the normal range. This will include any necessary follow-up sampling, analysis, and investigation to help identify the likely source of exposure, and to implement an appropriate response that will help reduce the exposure.

A key component of the response program is that all potential sources of lead at a property would be sampled, including soil and interior/exterior paint. If soil is judged to be the most likely source of exposure, a series of alternative actions will be evaluated to identify the most effective way to reduce that exposure. These will include a wide range of potential alternatives, including such things as education, sodding or capping of contaminated soil, tilling/treatment, etc. If exterior paint is the source of lead contamination in soil, remediation of the paint may be considered. If the main source is judged to be non-soil related, responses may include things such as education and counseling, or referral to environmental sampling/response programs offered by other agencies, as appropriate.

PUBLIC HEALTH PROGRAM TO REDUCE RISKS FROM PICA INGESTION OF ARSENIC

Chronic cancer and non-cancer risks from incidental ingestion of arsenic in soil will be addressed by the soil removal/disposal component of this remedial alternative. The public health alternative for arsenic is designed to focus specifically on the potential risks to young children from pica behavior. The program for arsenic will consist of three main elements:

1) Community and individual education about identification and potential hazards of pica behavior and the potential health consequences of excessive acute oral exposure to arsenic.

2) A biomonitoring program by which any child may be tested to evaluate actual soil pica exposure to arsenic.

3) A program to respond to any observed inorganic arsenic exposures that are outside the normal range. This will include any necessary follow-up sampling, analysis, and investigation to help identify the likely source of exposure, and to implement an appropriate response that will help reduce the exposure.

- In yards with arsenic EPCs greater than 240 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil containing arsenic and lead below PRGs, and pre-remediation yard features restored. Based on RI data, it is estimated that this would occur at a total of 113 residential properties within the entire site.

- In yards with lead EPCs greater than 540 mg/Kg, surface soils would be tilled to a depth of 6 inches and treated with phosphate. Pre-remediation yard features would then be restored. Based on RI data, it is estimated that this would occur at a total of 89 residential properties at the site (it is estimated that 8 of the properties with lead EPCs above 540 mg/Kg also have arsenic EPCs above 240 mg/Kg and would therefore be remediated by soil removal).

- To date, EPA has sampled the soil at approximately 75% of the residential properties within the VBI70 site boundary. Because the spatial pattern of lead and arsenic contamination is variable between properties, it is not possible to assess potential risks at a specific property without data from that property. Therefore, upon request from the owner or current resident (if access is granted by the owner), EPA will provide a program of on-going testing for lead and arsenic in soil at any residential property within the site boundaries that has not already been adequately tested. If the lead EPC exceeds 540 mg/Kg and the arsenic EPC is below 240 mg/Kg, soil at the property would be tilled and treated with phosphate. If the arsenic EPC exceeds 240 mg/Kg, soil would be removed and disposed offsite. This sampling program will operate for as long as the remedy operates.

Alternative 3 – Community Health Program, Targeted Removal and Disposal

Alternative 3 contains the following principal components:

- Implementation of a community health program, identical to the one described for Alternative 2, except that in future response actions on soils would entail removal and offsite disposal.

- In yards with arsenic EPCs greater than 240 mg/Kg or with lead EPCs above 540 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil containing arsenic and lead below PRGs, and pre-remediation yard features restored. Based on RI data, it is estimated that this would occur at a total of 202 residential properties (105 properties for arsenic only, 8 for both arsenic and lead, and 89 for lead only).

- Implementation of a sampling program identical to the one described under Alternative 2. Under this alternative, at properties with lead EPCs greater than 540 mg/Kg or with arsenic EPCs greater than 240 mg/Kg, soil would be removed and disposed offsite.

Alternative 4 – Community Health Program, Expanded Removal and Disposal

Alternative 4 contains the following principal components:

- Implementation of a community health program, identical to the one described for Alternative 3.

- In yards with arsenic EPCs greater than 128 mg/Kg or with lead EPCs above 540 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil containing arsenic and lead below PRGs, and pre-remediation yard features restored. Based on RI data, it is estimated that this would occur at a total of 403 residential properties (306 properties for arsenic only, 31 for both arsenic and lead, and 66 for lead only).

- Implementation of a sampling program identical to the one described under Alternative 2. Under this alternative, at properties with lead EPCs greater than 540 mg/Kg or with arsenic EPCs greater than 128 mg/Kg, soil would be removed and disposed offsite.

Alternative 5 – Removal and Disposal

Alternative 5 contains the following principal components:

- In yards with arsenic EPCs greater than 47 mg/Kg or with lead EPCs above 208 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil containing arsenic and lead below PRGs, and pre-remediation yard features restored.

This alternative would also include sampling of properties that were not sampled during the RI with soil removal at properties where lead or arsenic exceed the action levels. It is estimated that soil removal would be required at a total of 2,122 residential properties.

COMPARATIVE ANALYSIS OF ALTERNATIVES

The remedial alternatives were evaluated against the threshold and balancing criteria specified in the NCP and FS Guidance to ensure that the selected remedial alternative will: protect human health and the environment; comply with or include a waiver of Applicable or Relevant and Appropriate requirements (ARARs); be cost-effective; utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and address the statutory preference for treatment as a principal element. The modifying criteria of State and Community acceptance will be addressed by the USEPA after the FS is completed and prior to the finalization of the Record of Decision.

The nine evaluation criteria specified in the National Contingency Plan (NCP) are:

- Threshold Criteria
  - Overall Protection of Human Health and the Environment
  - Compliance with ARARs

- Primary Balancing Criteria
  - Short-Term Effectiveness
  - Long-Term Effectiveness and Permanence
  - Reduction of Toxicity, Mobility and Volume Through Treatment
  - Implementability
  - Cost

- Modifying Criteria
  - State Acceptance
  - Community Acceptance

Detailed analyses were performed for each alternative, applying each of the threshold and primary balancing criteria. The remedial alternatives were also evaluated comparatively, relative to one another, within each criterion.

The No Action Alternative is not evaluated in the comparative analysis, but is considered as the baseline condition. The Baseline Human Health Risk Assessment indicates that no further action would be effective in preventing exposures to arsenic in soil above a 1×10^{-4} lifetime cancer risk, a chronic hazard greater than 1, or a sub-chronic hazard quotient greater than 1 for residents who have average or central tendency exposures. However, if no further action is taken at the site, screening level calculations suggest that high rates of soil intake associated with soil pica behavior in children might result in doses of arsenic which exceed an acute hazard quotient of 1, even for the central tendency pica exposure scenario. Also, no further action would not meet the RAOs for arsenic since they are established to be protective of RME exposures.

For lead, in order to help determine whether the IEUBK model is yielding reliable predictions at the VB/I70 site, USEPA compared the IEUBK model predictions to actual observations of blood lead levels in the population of children currently living at the site. Even though the available data are from studies that were not designed to support risk assessment, they do support the following:

A. Elevated blood lead levels occur in children residing within the site.
B. Soil is not likely to be the main source of elevated blood lead levels.
C. Elevations are not clearly different from areas outside VB/I70.

One alternative IEUBK model run using recently published data on soil ingestion rates for children (Stanek & Calabrese, 2000), the site-specific relative bioavailability and site specific soil/dust ratio adjustments predicts that no further action would be effective in achieving the RAO for lead. The IEUBK model run using default assumptions for all parameters except the site specific relative bioavailability and soil/dust ratio predicts that no further action would not be effective in achieving the RAO for lead in soil. The range of results reflects the uncertainty in predicting whether further action is required to achieve the RAO for lead at the site.

A summary of the comparative analysis is provided below.

Overall Protection of Human Health

There is not a large difference is the performance of each of the alternatives against this criterion. Overall, however, the highest level of protection of human health as measured by the requirements of the RAOs, would be achieved by Alternative 3. Removal and offsite disposal of yard soils with arsenic EPCs above 240 mg/Kg or lead EPCs greater than 540 mg/Kg would be effective in preventing exposure to these soils, which are of the greatest concern with respect to human health risk. For other properties, implementation of a community health program would be expected to be effective in managing the remaining risks from soils due to the components of education, biomonitoring, source sampling and analysis, and response actions as necessary. In addition, the community health program would provide additional protection for the community, because it would provide the mechanism for evaluating other sources of lead (such as lead paint) that may cause exposures in the future, and for evaluating soil pica behavior which may be associated with other risks in addition to the risk of acute arsenic exposure.

Alternative 2 may provide a similar level of protection compared to Alternative 3, but there is some uncertainty associated with the tilling/treatment component to address soils with lead EPCs above 540 mg/Kg. Uncertainties are associated with the effect of tilling on surface soil concentrations (concentration profiles were not generated with depth or in different yard locations for the target properties, and therefore the resultant lead concentrations in surface soil after tilling are difficult to predict). Also, the effectiveness of phosphate treatment is uncertain (site-specific testing would be required to determine the chemical form and application rate; this would lead to a delay of at least a year in implementing this portion of the remedy).

Alternative 4 differs from Alternative 3 by adding soil removal from properties with arsenic concentrations greater than 128 mg/Kg. This alternative was developed and evaluated based on CDPHE comments regarding cleanup goals at the adjacent Globeville site (see Appendix D). Based on the findings of the Baseline Human Health Risk Assessment, this arsenic EPC corresponds to a point estimate risk level of 8 x 10^{-5}. Therefore the additional removal would address risks within EPA's acceptable risk range and would provide this level of protection for the 99th percentile of the exposed population; exposures which are very likely not occurring at the site. The RAO to prevent additional lifetime cancer risk due to ingestion of arsenic in soil and homegrown vegetables was established based on the findings of the risk assessment, consistent with the guidance set out in the OSWER Directive 9355.0-30 "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions". In part, this guidance states that "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less that 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, action is not warranted unless there are adverse environmental impacts." The directive further states that consideration of uncertainties in the baseline risk assessment may lead a risk manager to decide that risks lower than 10^{-4} are unacceptable, triggering the need for remedial action. EPA considered the uncertainty in the arsenic risk calculations for VB/I70 to determine whether remedial action is needed at properties where risks are predicted to be less than or equal to 10^{-4}. The uncertainty analysis in the Baseline Human Health Risk Assessment indicates that actual risks are much more likely to be lower than the calculated point estimates of risks. Providing protection at the 1 x 10^{-4} risk level based on the point estimates of risk is likely to provide a level of protectiveness for the RME scenario in the range of 2 x 10^{-5} to 7 x 10^{-5}. Therefore, it is not necessary to perform soil removals where arsenic EPCs exceed 128 mg/Kg in order to achieve protectiveness in this range for the RME scenario.

Alternative 5 would provide the highest level of long-term protection and permanence against risks associated with soils because soils with arsenic and lead at levels of concern would be removed from the site. However, the extensive removals would entail short-term risks to the community due to the presence and operation of heavy equipment and the large number of truck trips required to dispose excavated soil offsite and to transport clean fill to the site. In addition, from a community perspective Alternative 5 may not provide the highest overall protection since it is likely that other sources of lead exist that would not be identified under this alternative and the occurrence of soil pica behavior would not be affected. The USEPA sponsored a study in urban areas of Baltimore, Boston and Cincinnati to investigate the efficacy of soil and dust abatement techniques in reducing blood lead values in children (USEPA 1995). Because of the study design, this investigation is usually referred to as the "three cities study". Among the key findings of this study was the conclusion that:

"... soil abatement alone will have little or no effect on reducing exposure to lead unless there is a substantial amount of lead in soil and unless this lead is the primary source of lead in house dust"

The report did not rigorously define "substantial", but it was only when soil lead levels were higher than 1,000 to 2,000 mg/Kg that a benefit from soil remediation was detectible. Conversely, in two cities where soil lead levels were mainly less than 1,000 mg/Kg, no substantial decrease in blood leads could be detected following soil remediation. As noted earlier, 99% of all properties tested in Phase III at the VB/I70 site have soil lead concentrations below 700 mg/Kg, with only three properties being above 1,000 mg/Kg. Also recall that, at the VB/I70 site, available data indicate that only about 34% of the mass of interior dust appears to be derived from yard soil. Thus, it appears that neither of the two conditions needed for soil removal to be effective are likely to apply at most properties at the VB/I70 site.

<u>Compliance with Applicable or Relevant and Appropriate Requirements</u>

All of the remedial alternatives evaluated in the comparative analysis would be expected to comply with ARARs. ARARs relating to the generation of fugitive dust and lead concentrations in ambient air would be applicable to the range of engineering actions under evaluation. Although the potential exists for dust generation during soil tilling and excavation, and transport and backfilling activities, engineering controls would be readily implementable and effective to achieving compliance with the applicable regulations. ARARs relating to the characterization, transport and disposal of solid wastes would be applicable for excavated soils and would be met by standard construction and transportation practices.

Short-Term Effectiveness

Alternative 3 provides the highest level of short-term effectiveness. Soil removal actions could be quickly and effectively implemented with little risk to workers or the community. Implementation of the community health program would be expected to be effective in managing the risks in other portions of the site related to lead and arsenic in soils due to the components of education, biomonitoring, soil sampling and analysis, and response actions when warranted.

Alternative 2 provides a slightly lower level of short-term effectiveness than Alternative 3, primarily because tilling/treatment actions would be delayed while treatability testing was performed and because there would be some uncertainties with the immediate effectiveness of the tilling/treatment activities due to lack of data on lead concentrations with depth and at different locations in the targeted yards.

Alternative 4 provides a slightly lower level of short-term effectives than Alternative 3, primarily because additional removals at properties with arsenic EPCs greater than 128 mg/Kg would entail greater risks due to the larger scope of removal actions and transportation of excavated soil and clean backfill through neighborhood streets, while not contributing to additional long-term protection of human health as set out by the requirements of the RAOs.

Alternative 5 would provide the lowest level of short-term effectiveness because of increased risks to workers and the community due to the long-term operation of heavy equipment in the residential areas and by truck traffic associated with transportation of excavated soil offsite and import of clean backfill (approximately 43,000 truck trips would be required).

Long-Term Effectiveness and Permanence

Alternative 5 would provide the highest level of long-term effectiveness and permanence against risks associated with soils, because all soil with lead or arsenic EPCs above levels of concern would be removed from the site. However, from a community perspective it may not provide the highest overall protection since it is likely that there are other sources of lead (such as lead-based paint), which would not be evaluated and the occurrence of soil pica behavior would not be affected. Alternatives 2, 3 and 4 would provide a high level of long-term effectiveness by addressing soils with lead or arsenic EPCs at levels above risk-based objectives by tilling and treatment and/or removal. Risks associated with remaining yard soils would be effectively managed by implementation of a community health program under these alternatives. The program would provide the additional benefit to the community of providing a mechanism for identifying sources of lead exposure other than soils and abatement (abatement of exterior lead-paint would be performed under this program if soils at a property are an issue, or by referral to another program if soils are not an issue), and a program to reduce the likelihood of soil pica behavior in children within VB/I70.

Reduction of Toxicity, Mobility or Volume Through Treatment

Alternatives 3, 4 and 5 do not contain a treatment component and therefore Alternative 2 would result in the highest reduction of toxicity and mobility due to treatment. However, there are uncertainties with the treatment process and site-specific testing would have to be performed to evaluate the chemical form and application rate of phosphate and to evaluate the overall treatment effectiveness once implemented.

Implementability

Alternatives 3, 4 and 5 would be readily implementable with standard equipment and services, and adequate personnel would be readily available for this type of work. The construction technologies required to implement these alternatives are commonly used and widely accepted. For Alternative 2, tilling of residential soils may be difficult to implement. Areas of accessible soils within yards are relatively small and typically have features such as trees or large shrubs, which would make access and implementation of deep tilling difficult unless the features were removed and replaced. It is likely that due to access constraints tilling would have to be performed using rototillers, which typically have a working depth of about 6 inches. Lead concentrations with depth have not been generated for the target properties and if deeper tilling is found to be necessary to meet the RAOs it would be difficult to implement.

Cost

Estimated costs for each alternative considered in the comparative analysis are shown below. These costs include direct and indirect capital costs and review costs for 30 years (there are no operation and maintenance costs associated with any of the alternatives).

Remedial Alternative	Net Present Worth Cost (Millions)
Alternative 2	10.6
Alternative 3	11.1
Alternative 4	17.5
Alternative 5	61.0 (1)

Note: (1) Of this amount, approximately $15.6 million is associated with remediation of properties with arsenic EPCs above 47 mg/Kg but below 128 mg/Kg.

All alternatives meet the threshold requirements of protection of human health and compliance with ARARs. Alternative 3 provides a greater level of overall certainty for protecting human health compared to Alternative 2 and entails lower costs than Alternatives 4 and 5.

1.0 INTRODUCTION

This document presents the Feasibility Study (FS) for the Off-Facility Soils Operable Unit of the Vasquez Boulevard and Interstate 70 (VB/I70) Superfund Site located in the north-central section of Denver, Colorado. The purpose of the FS is to identify and evaluate a range of remedial alternatives to address human health concerns associated with potential exposure to contaminated soils and homegrown vegetables in residential yards. This FS has been prepared in accordance with EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9355.3-01, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, (EPA, 1988a).

1.1 Site Description

The VB/I70 site covers an area of approximately four square miles in north-central Denver, Colorado. For the purpose of investigation and remedy development, the site has been divided into 3 operable units (OUs). The residential soils evaluated in this report are known as the Off-Facility Soils Operable Unit 1 (OU1) portion of the site. The locations of the former Omaha & Grant Smelter and Argo Smelter are identified as On-Facility Soils OU2 and OU3, respectively. The site is composed of a number of neighborhoods that are largely residential, including Swansea/Elyria, Clayton, Cole, and portions of Globeville. Most residences at the site are single-family dwellings, but there are also some multi-family homes and apartment buildings. There are approximately 4,000 residential properties within the site boundaries. The site also contains a number of schools, parks, and playgrounds, as well as commercial and industrial properties.

1.2 OU1 Project History

The site came to the attention of the U.S. Environmental Protection Agency (USEPA) following studies directed by the Colorado Department of Public Health and Environment (CDPHE) at the nearby

Globe Smelter. These studies had identified elevated concentrations of arsenic and/or lead in residential yards within Globeville, and also extending into the Elyria and Swansea neighborhoods (Washington Group, 2001).

The USEPA Emergency Response Program conducted two removal assessment-sampling programs, known as Phase I and Phase II, at residential properties within the VB/I70 study area during 1998. The sampling results at 18 properties warranted time critical soil removal based on surface soil concentrations exceeding 450 mg/Kg arsenic or 2,000 mg/Kg lead (USEPA, 1998).

Based on the Phase I and Phase II results, the USEPA determined that residential properties within the VB/I70 site contained soils with arsenic or lead at levels that could present human health concerns over long-term exposures. On this basis, the site was proposed for listing and was added to the National Priorities List (NPL) on July 22, 1999.

A study and two additional investigations were performed between 1998 and 2000 in support of the Baseline Human Health Risk Assessment:

- Physico-Chemical Characterization Study
- Residential Risk Based Sampling Investigation
- Phase III Field Investigation

The Physico-Chemical Characterization Study conducted analyses on existing Phase I soil samples to generate supplementary data on the physical and chemical characteristics of the surface soils, including the relationship between bulk and fine soil fractions, contaminant phases and particle sizes, and the *in vitro* bioaccessibility of arsenic and lead in site soils.

The Residential Risk-Based Sampling Investigation involved collection of soil, dust, paint, tap water, vegetables, and biological samples and analysis for arsenic, lead, cadmium, and zinc.

The Phase III Investigation was planned in early 1999 and implemented between August 1999 and November 2000. The investigation focused on residential surface soil sampling but also included indoor dust sampling, garden soil and vegetable sampling, and school and park sampling. The sampling program initially targeted those properties that had not been sampled during the 1998 Phase I or Phase II events, and subsequently encompassed all residential properties after the USEPA determined that the Phase I and Phase II sampling design was inconsistent with the statistically based Phase III design, and that the earlier results were too limited to support a reliable risk assessment. Based on the results of the Phase III investigation, time critical removals were performed at an additional 30 properties where arsenic concentrations exceeded 400 mg/Kg as the 95% upper confidence limit of the yard average.

Data generated from these investigations are reported in the Remedial Investigation (RI) report (Washington Group, 2001), which was issued in final form in July 2001. The Baseline Human Health Risk Assessment was issued in final form in August 2001 (USEPA, 2001a).

1.3 Report Organization

The organization of the FS and a brief description of the contents of each section are presented below.

Executive Summary

The Executive Summary provides a brief overview of the FS.

Section 1.0 – Introduction

The introduction includes a description of the site, a brief history of the project for OU1, and describes the overall structure of this FS document.

Section 2.0 - Summary of RI Findings

This section provides a summary of data and information from the RI relevant to the identification and evaluation of remedial alternatives for VB/I70 OU1.

Section 3.0 - Remedial Action Objectives

This section provides the Remedial Action Objectives (RAOs) for OU1. The RAOs are developed based on the exposure pathways and contaminants of concern. Preliminary remediation goals are also established based on the exposure pathways and contaminants of concern and on a preliminary identification of potential applicable or relevant and appropriate requirements (ARARs).

Section 4.0 – Identification and Screening of Remedial Technologies and Process Options

This section presents the development of General Response Actions, and identification and screening of remedial technologies and process options. The remedial technologies and process options are screened in two stages. In the first screening step, technologies that have limited or no potential for implementation at the site are eliminated. Remedial technologies and process options that pass the initial screening test are subjected to a second, more rigorous, screening evaluation of their anticipated effectiveness, potential implementability and relative cost. The remedial technologies and process options that survive the screening are carried forward for consideration in the development of remedial alternatives, as described in Section 5.0

Section 5.0 – Development of Remedial Alternatives

This section provides a detailed description of the five remedial alternatives developed for VB/I70 OU1. The alternatives are developed by assembling logical combinations of the remedial technologies and process options that survived the screening process, described in Section 4.0.

Section 6.0 - Detailed Analysis of Remedial Alternatives

This section presents the detailed analyses of each of the remedial alternatives. The alternatives are evaluated against the threshold and primary balancing criteria specified in the National Contingency Plan (NCP) and FS guidance to ensure that the selected alternative will: protect human health and the environment; comply with or include a waiver of ARARs; be cost-effective; utilize permanent solutions to the maximum extent practicable; and address the statutory preference for treatment as a principal element.

Section 7.0 - Comparative Analysis

This section presents a comparative analysis of the remedial alternatives. The purpose of this analysis is to compare the advantages and disadvantages of each remedial alternative brought forth in the detailed analysis, described in Section 6.0. The comparison focuses on the significant areas of difference, especially identification of any alternative that is clearly superior in meeting the requirements of an evaluation criterion.

Section 8.0 - References

This section lists references and data sources that were used to develop the FS report.

2.0 SUMMARY OF RI FINDINGS

This section provides a summary of data and information from the RI (Washington Group, 2001) relevant to the identification and evaluation of remedial alternatives for VB/I70 OU1.

2.1 Study Area Investigations

As discussed in Section 1.0, a study and two investigations were performed between 1998 and 2000 in support of the Baseline Human Health Risk Assessment:

- Physico-Chemical Characterization Study
- Residential Risk Based Sampling Investigation
- Phase III Field Investigation

The Physico-Chemical Characterization Study conducted analyses on existing Phase I soil samples to generate supplementary data on the physical and chemical characteristics of the surface soils, including the relationship between bulk and fine soil fractions, contaminant phases and particle sizes, and the *in vitro* bioaccessibility of arsenic and lead in site soils. Pertinent conclusions from this study were:

- The primary chemical phase of arsenic in site soils is arsenic trioxide, while lead is present as lead phosphate, lead arsenic oxide and lead manganese oxide.

- Both arsenic and lead predominantly exist in particles which range from less than 5 to 49 micrometers in size; lead is also consistently found in particles 50-149 micrometers in size.

- The relative percent bioaccessibility (which is related to, but is not the same as, relative bioavailability) ranges between 3-26% for arsenic and 64-83% for lead.

The Residential Risk-Based Sampling Investigation involved collection of soil, dust, paint, tap water, vegetables, and biological samples. Soil samples were collected from five properties where time critical soil removal was warranted and from three other properties on a five-foot grid and analyzed for arsenic, lead, cadmium, and zinc. Additional sampling was performed at eighteen properties that warranted time critical removal. Where possible, garden soil samples, vegetable samples, and dust samples from living areas and attics were collected and analyzed for arsenic, cadmium, lead, and zinc. At these homes, paint and tap water samples were collected and analyzed for lead. Biological samples of blood, hair and urine were collected from fifteen residents from six properties. The urine and hair samples were analyzed for arsenic. The blood samples were analyzed for lead. The investigation resulted in the following principal findings:

- Several properties show large variations in surface soil concentrations within the property, and a marked change in arsenic and lead concentration at the property boundary as compared to concentrations on the immediately adjacent property.
- Metals concentrations decrease with depth and generally are highest in the first two inches of soil.
- Although the data set is too small to draw definite conclusions, the dust sampling results suggest that outdoor soil is not a major determinant of arsenic or lead levels in indoor dust in living areas. There is also no significant correlation for arsenic or lead between the concentration in living space dust and attic dust.
- Lead was detected in paint at most locations where paint was sampled, with 130 out of 144 samples having values above 1 mg/cm^2. These data suggest that interior and/or exterior leaded paint might be a source of lead exposure in area children, either directly (by paint chip ingestion), or indirectly (by ingestion of dust or soil containing paint chips) (USEPA, 2001a).
- The biomonitoring data do not suggest that exposure levels to lead and arsenic in the individuals tested were significantly greater than normal. Because of the small number of participants, these biomonitoring data must be interpreted with caution.

The Phase III Investigation was planned in early 1999 and implemented between August 1999 and November 2000. The investigation focused on residential surface soil sampling, but also included indoor dust sampling, garden soil and vegetable sampling, and school and park sampling. Soil sampling within alleyways was planned but not implemented due to a lack of unpaved alleys in the study area. The sampling program initially targeted those properties that had not been sampled during the 1998 Phase I or

Phase II events, and subsequently encompassed all residential properties after the USEPA determined that the Phase I and Phase II sampling design was inconsistent with the statistically based Phase III design, and that the earlier results were too limited to support a reliable risk assessment. During Phase III, a total of 3007 properties were sampled, including 2989 residential properties, ten schools, seven parks, and one government property. Garden vegetables and soils were sampled at 19 properties and indoor dust was collected at 75 properties. The investigation succeeded in gaining access to and sampling 76% of all residential properties within the study area.

Residential surface soils (0-2 inches) were characterized by collection of three ten-point composites and analysis of the bulk fraction for arsenic and lead using an energy dispersive x-ray fluorescence (XRF) spectrometer. The thirty sub samples were collected from locations equally distributed throughout the yard and were sequentially grouped into composites such that each of the three composites represented an average concentration over the entire yard. Individual grab surface soil samples were later collected at 119 properties to evaluate whether observed values approach the theoretical arsenic hot spot concentration, which could present unacceptable risks if a large mass of soil from such a hot spot were to be ingested in a short time frame.

All Phase III analytical results were reviewed and validated against quality control criteria specified in the EPA-approved Quality Assurance Project Plan to confirm that the data quality objectives were met. This data set resulted in the following principal findings pertinent to identification and evaluation of remedial alternatives:

- The majority of properties have low levels of arsenic. Thirty-one percent of the properties have the 95% upper confidence of the mean either being below the method detection limit of 11 mg/Kg, or near the method detection limit.
- Ninety-one percent of the properties contain mean lead concentrations below the EPA screening level for lead in soil of 400 mg/Kg.
- It is estimated that background levels of arsenic are well-characterized as a lognormal distribution with a mean of 8 mg/Kg and a standard deviation of 3.6 mg/Kg. Based on this, background levels may range up to about 15 mg/Kg or slightly higher (USEPA, 2001a).

- Lead levels in bulk soils range from below the detection limit (about 52 mg/Kg) up to a maximum of more than 1,000 mg/Kg. If it is assumed that the upper range of lead concentrations resulting from natural and area-wide anthropogenic sources is about 400 mg/Kg, then the mean of all samples that are less than 400 mg/Kg is about 195 mg/Kg.

- There is only a weak correlation between the occurrence of elevated lead and elevated arsenic in soil, suggesting that the main sources of lead and the main sources of arsenic in yard soil are not likely to be the same.

- Some residential properties contain arsenic at concentrations substantially higher than the expected natural levels. Properties with elevated levels of arsenic occur at widely scattered locations across the site with no clear spatial pattern. At an affected property, the contamination appears to be distributed across the yard area, with a fairly clear boundary between the affected property and the adjacent property. The chemical form of arsenic at these properties is predominantly arsenic trioxide (USEPA, 2001a).

- Lead also occurs at elevated levels in soil at some residential properties. Elevations occur in all neighborhoods of the site, but levels tend to be higher on the western part of the site than the eastern part.

- Concentrations of arsenic and lead in indoor dust and garden vegetables remain relatively consistent over a wide range of yard soil concentrations.

- Mean arsenic concentrations in surface soils in schools and parks range from below the method detection limit of 11 mg/Kg to 26 mg/Kg. The mean lead concentrations range from 67 to 256 mg/Kg.

2.2 Nature and Extent of Contamination

The Phase III data were evaluated using statistical methods to characterize the nature and extent of arsenic and lead contamination and to evaluate potential historical sources. A variogram analysis examined the spatial continuity and trends of arsenic and lead. A kriging analysis was performed to identify whether or not spatial patterns are random or continuous. These analyses indicated the following:

- Variogram graphs at the VB/I70 site do not exhibit structures similar to those found at other environmental sites that have sources of contamination where wind is a significant dispersion mechanism (i.e., sites where the principal source of contamination is deposition of air emissions).

- For arsenic, numerous small areas of soil concentrations greater than 300 mg/Kg were found. These areas are widely distributed and fairly randomly scattered. Distinct lineations are not present, nor are the features resembling concentric bands of decreasing concentrations as one moves away from the former smelter areas. This suggests that the emplacement mechanism for arsenic did not occur on a regional scale (i.e., from deposition of air emissions), but rather took place in random, isolated pockets of the site.

- Lead shows a more spatially structured nature to the contamination. Lead concentrations in soils closest to the former smelter sites are generally the highest, with a relatively systematic reduction in concentrations as one moves away radially from the area of the former smelters. The kriged geostatistical model for lead indicates both regional emplacement (i.e., deposition of air emissions) and random emplacement, likely indicating the effect of other urban sources, such as lead paint.

2.3 Baseline Human Health Risk Assessment

The risk assessment used data generated under the Phase III Field Investigation, supplemented by the results of the Physico-Chemical Soil Characterization and Residential Risk Based Sampling programs and two additional studies on the relative bioavailability of lead and arsenic in soils from the VB/I70 site (USEPA, 2001b and 2001c). The assessment identified the following potential health risks to residents at the site, assuming that no remedial actions are conducted.

Arsenic

In some cases, levels of arsenic in yard soil are sufficiently elevated to pose a reasonable maximum exposure (RME) excess lifetime cancer risk above a level of 1E-04. Based on current data, about 3 percent of all properties fall into this category. Monte Carlo modeling performed as part of the uncertainty analysis in the Baseline Human Health Risk Assessment indicates that the RME point estimate is located at or about the 99th percentile of the probability distribution of risk. Non-cancer risks from chronic or sub-chronic RME exposures to arsenic are also above a level of human health concern at some properties. All of these properties are also predicted to have RME cancer risks above 1E-04.

Screening level calculations suggest that high level intake of soil associated with pica behavior in children might be of acute non-cancer concern at a large number of properties at the site. Because data are so sparse on the actual magnitude and frequency of soil pica behavior, and considering that discussions continue to occur nationally on the most appropriate acute Reference Dose (RfD) for arsenic, it is difficult to judge which (if any) of these properties should be considered to be an authentic acute health risk to children. In this regard, it should be noted that even though many people are exposed to arsenic levels in soils that are predicted to be of acute concern, both within the VB/I70 site and elsewhere across the country and around the world, to the best of USEPA's knowledge, there has never been a single case of acute arsenic toxicity reported in humans that was attributable to arsenic in soil. Thus, these results for the acute pica scenario are considered to be especially uncertain, since they predict a very substantial risk for which there is no corroborating medical or epidemiological evidence.

Lead

Using EPA's IEUBK model (adjusted with site-specific data on lead in dust and on the relative bioavailability of lead in soils) to evaluate the risk to children, it is estimated that about 45% of residences have levels that exceed USEPA's health-based goal (no more than a 5% chance that a child or group of similarly exposed children will have a blood lead value above 10 µg/dL). Of these, many (about 71%) have mean lead concentrations lower than 400 mg/Kg (the USEPA screening level for lead in soil). This is mainly because the site-specific relative bioavailability for lead (84%) is higher than the IEUBK model default value (60%).

In order to help determine whether the IEUBK model is yielding reliable predictions at the VB/I70 site, USEPA compared the IEUBK model predictions to actual observations of blood lead levels in the population of children currently living at the site. Even though the available data are from studies that were not designed to support risk assessment, they do support the following:

A. Elevated blood lead levels occur in children residing within the site.
B. Soil is not likely to be the main source of elevated blood lead levels.
C. Elevations are not clearly different from areas outside VB/I70.

In order to investigate the uncertainty of the IEUBK model predictions, USEPA performed alternate IEUBK modeling by revising the model parameters using newly published data. Using the most-recent data available on soil intake rates by children measured during a study by Stanek and Calabrese (Stantek & Calabrese, 2000), the IEUBK model predicts that there are no residences where USEPA's health based goal will be exceeded.

3.0 REMEDIAL ACTION OBJECTIVES

This section provides the RAOs for VB/I70 OU1. Exposure pathways and contaminants of concern identified in the Baseline Human Health Risk Assessment are described in Section 3.1. Section 3.2 provides a preliminary evaluation of potential ARARs. Based on these factors and site conditions, RAOs are provided in Section 3.3. Preliminary remediation goals (PRGs) are established, as described in Section 3.4. PRGs are generally medium-specific chemical concentrations that will pose no unacceptable threat to human health and the environment.

Under CERCLA, the USEPA established an evaluation process for selecting remedies that are protective of human health and the environment, maintain such protection over time, and minimize the amount of untreated waste. EPA guidance in OSWER Directive 9355.0-30, "Role of the Baseline Human Health Risk Assessment in Superfund Remedy Selection Decisions" states that where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, remedial action generally is not warranted.

As discussed in Section 2.3, estimated human health risks at some individual properties within the site exceed these levels and therefore remedial action is warranted at these properties. Remedial alternatives are developed to reduce exposure to acceptable levels (i.e., preliminary remediation goals) at properties where actions are warranted.

The NCP identifies the following as acceptable exposures:

- For non-carcinogens, an acceptable exposure is one that incorporates an adequate margin of safety so that human populations, including sensitive subgroups such as children and pregnant women, may incur the exposure without adverse effects during a lifetime or a part of a lifetime.

- For carcinogens, the remedial goal should correspond to a risk value that falls within the range of 10^{-4} and 10^{-6} excess lifetime cancer risk.

3.1 Exposure Pathways and Contaminants of Concern

Based on the findings of the risk assessment, the exposure pathways of concern for adult residents in VB/I70 OU1 are long-term incidental ingestion of soil and dust in and about the home and yard, and long-term ingestion of home-grown vegetables. For children, the exposure pathways of concern are short-term incidental ingestion of soil in the yard and of indoor dust. Also for pica children, there is a concern about short-term high intake of yard soil that is associated with soil pica behavior. The contaminants of concern are arsenic and lead.

3.2 Applicable or Relevant and Appropriate Requirements

This section provides a preliminary evaluation of potential ARARs that may be pertinent to remedial actions at VB/I70 OU1. Federal standards, requirements, criteria or limitations that are determined to be legal ARARs must be met by remedial actions, as required by CERCLA (Section 121(d)(2)(A)). Also, State ARARs must be met if they are more stringent than Federal requirements. ARARs are designed to assure that potential remedial actions at a site are protective of human health and the environment, cost-effective, and use permanent solutions, alternative treatment technologies or resource recovery technologies to the maximum extent practicable (EPA, 1988a). The Superfund Amendments and Reauthorization Act (SARA) requires that any hazardous substance or pollutant remaining on a site must meet the level or standard of control that is established by the ARARs for that site, unless the ARAR is waived.

Applicable requirements are defined by the NCP as those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a site (40 CFR 300.5).

Although a requirement may not be applicable as a matter of law, it may still be relevant and appropriate. A requirement is deemed relevant and appropriate if it regulates or addresses problems or situations sufficiently similar to those encountered such that it is well suited to that particular site. Determination of whether a requirement is relevant and appropriate is site-specific and determined by professional judgment based on the characteristics of the remedial action, the hazardous substances present at the site, and the physical circumstances of the site and of the release. In addition, only a portion of a requirement may be deemed relevant and appropriate (EPA, 1988b).

Compliance with all requirements found to be applicable or relevant and appropriate is required under SARA. A waiver from an ARAR may be obtained under certain circumstances (CERCLA Section 121(d)(4)). Other CERCLA statutory requirements, such as the requirement that remedies be protective of human health and the environment, cannot be waived. CERCLA Section 121(d)(2)(A) specifically limits the scope of State ARARs to standards, requirements, criteria, or limitations under environmental or facility siting laws that are promulgated and more stringent than Federal requirements.

ARARs are grouped into three categories:

- Chemical Specific;
- Location Specific; and
- Action Specific.

The NCP identifies a fourth category of information termed "to be considered" (TBC) when evaluating appropriate remediation goals or approaches. This fourth category generally includes Federal and State advisories, criteria or guidance that are not ARARs, and while not legally binding may be useful in developing CERCLA remedies (see 40 CFR 300.400(g)(3)).

The following sections provide a discussion of those requirements that have significant potential to be applicable or relevant and appropriate to remedial actions at VB/I70 OU1.

3.2.1 Potential Chemical-Specific ARARs

Chemical-specific requirements are based on health- or risk-based concentration limits or discharge limitations in environmental media (i.e., water, soil, air) for specific hazardous chemicals. These requirements may be used to set cleanup levels for the chemicals of concern in the designated media or to set a safe level of releases where releases occur as part of the remedial activity.

Sources for potential target cleanup levels include selected standards, criteria, and guidelines that are typically considered ARARs for remedial actions conducted under CERCLA. Potential chemical-specific ARARs are presented in Table 3-1 and discussed in detail below.

3.2.1.1 National Ambient Air Quality Standards

Typically, only major sources of air emissions (defined in Section 112 of the Clean Air Act as any source of toxic air pollutant that emits or has the potential to emit 10 tons per year of any listed hazardous air pollutant, or a combination of listed hazardous air pollutants of 25 tons of more) are subject to the National Ambient Air Quality Standards (NAAQS). Both lead and inorganic arsenic compounds are listed as hazardous air pollutants in Section 112. NAAQS have been established for 7 pollutants. Of these, only lead and PM10 are potentially of concern during remedial action at VB/I70 OU1. NAAQS are implemented through the Federal New Source Review Program and State Implementation Plans (SIPs). The Federal New Source Review Program addresses only "major sources". Emissions from Superfund remedial actions involving soil remediation at other similar sites did not qualify as "major sources" due to the relatively short-term nature of the construction actions and to engineering controls that are routinely employed to minimize generation of fugitive dust. Emissions associated with the remedial actions under consideration at the site would be limited to fugitive dust emissions associated with earth moving activities during construction. These activities would not constitute a major source. Therefore, attainment and maintenance of NAAQS pursuant to the New Source Review Program is not applicable. However, the standards relating to particulates and to lead are relevant and appropriate. The applicability of requirements implemented through the SIP is discussed below.

3.2.1.2 Colorado Air Pollution Prevention and Control Act

Pursuant to the Colorado Air Pollution Prevention and Control Act applicants for construction permits are required to evaluate whether the proposed source will exceed NAAQS. Construction activities associated with the proposed remedial actions at the site will be limited to generation of fugitive dust emissions. Colorado regulates fugitive emissions through Regulation No. 1. Compliance with applicable substantive provisions of the Colorado air quality requirements would be achieved by adhering to a fugitive emissions dust control plan prepared in accordance with Regulation No. 1. Monitoring requirements, if any, necessary to achieve these standards would be addressed in this plan.

Regulation No. 8 sets emission limits for lead from stationary sources. Potential sources of lead emissions associated with remedial action would not meet the definition of stationary sources, therefore the regulations are not applicable. However, the substantive portions of the regulations would be relevant and appropriate. Applicants are required to evaluate whether the proposed activities would result in the Regulation No. 8 lead standard being exceeded. The proposed remedial actions at the site are not expected to exceed the emission levels for lead, although some lead emissions may occur. Compliance with Regulation No. 8 would be achieved by adhering to a fugitive emissions dust control plan prepared in accordance with Regulation No. 1 (i.e., control of fugitive dust would result in adequate control of lead emissions, because lead concentrations in soils are relatively low). Monitoring requirements, if any, necessary to achieve these standards would be addressed in this plan.

3.2.2 Potential Location-Specific ARARs

Location-specific ARARs are restrictions placed on the types of remedial activities that may be implemented at particular site locations. The location of a site may be an important factor in determining the potential impact of remedial actions on human health and the environment. These ARARs may restrict or preclude certain remedial actions or they may apply only to certain portions of a site. Potential Federal location-specific ARARs for the site are presented in Table 3-2, and discussed below. The State did not identify any location-specific ARARs (CDPHE, 2001). As discussed, the OU is residential and no potential location-specific ARARs have been identified.

3.2.2.1 Solid Waste Regulations (RCRA Subtitle D, 40 CFR Part 257)

The Resource and Recovery Act (RCRA) Solid Waste Regulations provide general classification criteria for solid waste disposal facilities pertaining to locations, which are within a certain proximity to airports, flood plains, wetlands, fault areas, seismic impact zones, and unstable areas. Because remedial alternatives being evaluated for the site do not include on-site management of excavated soils, RCRA Subtitle D is not a potential location-specific ARAR.

3.2.2.2 Wetlands and Floodplain Management

Federal regulations governing wetlands would be applicable if remedial activities impact wetland areas. Specifically, Executive Order 11990 requires the avoidance of long- and short-term impacts associated with the destruction or modification of wetlands. However, given that the definition of OU1 is residential soils there are no wetlands within the VB/I70 OU1. Also, on-site disposal is not a component of any remedial alternative under consideration. Therefore, the Order is not an ARAR.

Executive Order 11988 on Protection of Floodplains requires that potential remedial activities be conducted to avoid adverse long- and short-term impacts associated with the occupation or modification of flood plains. Because of the residential setting of the OU, this Order is not an ARAR.

3.2.2.3 Endangered Species Act

The Federal Endangered Species Act and State Nongame Endangered or Threatened Species Act provide protection for threatened and endangered species and their habitats. Due to the urban setting of the site and focus of remedial alternatives on residential yards, the presence of threatened or endangered species is highly unlikely. However, the Acts would be applicable if endangered species were identified and affected by the selected remedial alternative.

3.2.2.4 Wilderness Act

The Wilderness Act limits activities within areas designated as wilderness areas or National Wildlife Refuge Systems. However, remedial activities being considered for the site will not impact any designated areas and the Act is not an ARAR.

3.2.3 Potential Action-Specific ARARs

Action-specific ARARs are usually technology or activity-based requirements or limitations on actions taken with respect to hazardous substances. These requirements are triggered by the remedial activities selected to accomplish a remedy. Because there may be several alternative actions for any remedial site, different requirements may be established. The action-specific requirements do not in themselves determine the remedial alternative, rather, they indicate how a selected alternative should be implemented to achieve the requirement. Table 3-3 lists and describes potential State action-specific

ARARs, which were provided by CDPHE in a letter to USEPA dated January 18, 2001 (CDPHE, 2001). Potential Federal action-specific ARARs are also listed on Table 3-3. The regulations on these tables represent potential action-specific ARARs for activities generally encountered in hazardous substance site remediation (e.g., generation, transportation, storage, disposal, etc.). Regulations regarding worker health and safety such as Occupational Safety and Health Administration (OSHA) requirements are not included because they are not environmental requirements and are therefore not technically ARARs.

3.2.3.1 Resource Conservation and Recovery Act Subtitle D

RCRA establishes criteria for determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health. Excavated soils at the site would be considered as solid wastes under Subtitle D of RCRA and therefore the Act is applicable to remedial activities that include excavation of soil.

3.2.3.2 Resource Conservation and Recovery Act Subtitle C

RCRA Subtitle C would be applicable to offsite disposal of excavated soil determined to be hazardous waste. However, soils excavated during the recent removal action at the site had higher lead and arsenic concentrations than soils being considered for future remediation and were not hazardous wastes. Based on these site conditions, RCRA Subtitle C is not expected to be triggered by remedial action, however, it is considered potentially applicable to actions involving excavation, transport and off site disposal.

3.2.3.3 National Ambient Air Quality Standards

As discussed in Section 3.2.1.1, only major sources of air emissions (defined in Section 112 of the Clean Air Act as any source of toxic air pollutant that emits or has the potential to emit 10 tons per year of any listed hazardous air pollutant, or a combination of listed hazardous air pollutants of 25 tons of more) are subject to the NAAQS. Both lead and inorganic arsenic compounds are listed as hazardous air pollutants in Section 112. NAAQS have been established for 7 pollutants. Of these, only lead and PM10 are potentially of concern during remedial action at VB/I70 OU1. Emissions from Superfund remedial actions involving soil remediation at other similar sites did not qualify as "major sources" due to the relatively short-term nature of the construction actions and to engineering controls that are routinely employed to minimize generation of fugitive dust. Emissions associated with the remedial actions under consideration at the site would be limited to fugitive dust emissions associated with earth moving activities during construction. These activities would not constitute a major source. Therefore, attainment and maintenance of NAAQS pursuant to the New Source Review Program is not applicable. However, the standards relating to particulates and to lead are relevant and appropriate.

3.2.3.4 Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act regulates the off-site transportation of hazardous materials and addresses the packaging, placarding, use of proper containers, and discharge-reporting activities. If remedial actions at the site entail off-site transportation of excavated soils, the Hazardous Materials Transportation Act would be potentially applicable if the soils were classified as hazardous wastes. However, as noted above soils previously removed at the site had higher concentrations of lead and arsenic than soils being evaluated for future remediation and were not hazardous wastes. The Hazardous Materials Transportation Act is not expected to be triggered by remedial action. However, it is considered to be potentially applicable to actions involving excavation and transport.

3.2.3.5 Potential State Action-Specific ARARs

Potential State action-specific ARARs were provided by CDPHE and are shown and described in Table 3-3.

3.3 Remedial Action Objectives

The overall RAO is to protect human health. Residents are assumed to be the primary population exposed to contaminated soil under the current and reasonably anticipated future land uses. The contaminants of concern based on the Baseline Human Health Risk Assessment are arsenic and lead. The following are the RAOs for OU1:

RAOs for Arsenic in Soil

A. For residents of the VB/I70 site, prevent exposure to soil containing arsenic in levels predicted to result in an excess lifetime cancer risk associated with ingestion of soil and ingestion of home grown garden vegetables which exceeds 1×10^{-4} using reasonable maximum exposure assumptions.

B. For residents of the VB/I70 site, prevent exposure to soil containing arsenic in levels predicted to result in a chronic or sub-chronic hazard quotient associated with ingestion of soil and ingestion of home grown garden vegetables which exceeds 1 using reasonable maximum exposure assumptions.

C. For children with pica behavior who reside in the VB/I70 site, reduce the potential for exposures to arsenic in soil that result in acute effects.

RAO for Lead in Soil

D. Limit exposure to lead in soil such that no more than 5 percent of young children (72 months or younger) who live within the VB/I70 site are at risk for blood lead levels higher than 10 ug/dL from such exposure.

This objective is consistent with EPA's guidance that EPA should "...limit exposure to soil lead levels such that a typical child or group of similarly exposed children would have an estimated risk of no more than 5 percent of exceeding the 10 ug/dL blood lead level."

3.4 Preliminary Remediation Goals

This section presents PRGs for lead and arsenic in soils. PRGs are contaminant levels in soils that are protective of human health for the various exposure scenarios. Remedial alternatives will be evaluated by how effectively they will achieve the established PRGs. The PRGs have been established based on the evaluation and findings of the Baseline Human Health Risk Assessment. Final remedial goals will be established in the Record of Decision (ROD).

As shown in Table 3-4, PRGs have been set at background concentrations for both lead and arsenic. As described in Section 2.0, it is estimated that background levels of arsenic are well-characterized as a lognormal distribution with a mean of 8 mg/Kg and a standard deviation of 3.6 mg/Kg. Based on this, background levels may range up to about 15 mg/Kg or slightly higher (USEPA, 2001a). Lifetime RME cancer risks associated with exposure to background levels at OU1 are approximately 1E-05. Lead levels in bulk soils range from below the detection limit (about 52 mg/Kg) up to a maximum of more than 1,000 mg/Kg. If it is assumed that the upper range of lead concentrations resulting from natural and area-wide anthropogenic sources is about 400 mg/Kg, then the mean of all samples that are less than 400 mg/Kg is about 195 mg/Kg.

In addition to these PRGs, EPA has established Preliminary Action Levels in this FS. These levels are exposure point concentrations (EPCs) above which some remedial action is warranted. An EPC is a conservative estimate of the mean concentration within an individual yard. These action levels are: (1) an EPC of 47 mg/Kg arsenic, which is the level at which the Baseline Human Health Risk Assessment predicts the RME acute non-cancer Hazard Quotient is greater than 1 for the Case 2 pica scenario; (2) an EPC of 240 mg/Kg arsenic, which is the level at which the Baseline Human Health Risk

Assessment predicts RME lifetime cancer risks exceed 10^{-4}; (3) an EPC of 208 mg/Kg lead, which equates to a less than 5% chance that any child will have a blood lead value above 10 ug/dL based on the IEUBK model adjusted by using site-specific data on the levels of lead in house dust and the relative bioavailability of lead in site soil; and (4) an EPC of 540 mg/Kg lead, which also equates to a less than 5% chance that any child will have a blood lead value above 10 ug/dl based on an alternate IEUBK model run (see Appendix C). These concentrations equate to the EPCs used in the Baseline Human Health Risk Assessment and any evaluation of concentrations of lead or arsenic in residential yard soils must use the same sampling methodology as the RI and same evaluation methodology as the risk assessment to provide comparable results.

4.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

This section presents the development of General Response Actions (GRAs), and identification and screening of associated remedial technologies and process options for VB/I70 OU1. GRAs are general categories of remedial activities (e.g. no action, institutional controls, containment, etc.) that may be taken, either singly or in combination, to satisfy the requirements of the RAOs. Remedial technologies and process options are more specific applications of the GRAs.

GRAs are identified in Section 4.1. Section 4.2 provides estimates of the number of residential properties with lead or arsenic EPCs above preliminary action levels. The remedial technologies and process options are screened in two stages. In the first screening step, described in Section 4.3, technologies that have limited or no potential for implementation at the site are eliminated. Remedial technologies and process options that pass the initial screening test are subjected to a second, more rigorous, screening evaluation of their anticipated effectiveness, potential implementability and relative cost, as described in Section 4.4. The remedial technologies and process options that survive the screening are carried forward for consideration in the development of remedial alternatives, as described in Section 5.0.

4.1 General Response Actions

GRAs are categories of general action types (i.e., treatment or containment), which may be applicable for remedial actions at the site. As presented in Section 2.0, key RI findings with respect to identification of GRAs and the development of remedial alternatives for VB/I70 OU1 are as follows:

- Generally, metals concentrations are highest in the first two inches of soil and decrease with depth.

- 91% of the properties contain mean lead concentrations below the EPA soil screening level of 400 mg/Kg.

- It is estimated that background levels of arsenic are well characterized as a lognormal distribution with a mean of 8 mg/Kg and a standard deviation of 3.6 mg/Kg. Based on this, background levels may range up to about 15 mg/Kg or slightly higher.

- Lead levels in bulk soils range from below the detection limit (about 52 mg/Kg) up to a maximum of more than 1,000 mg/Kg. If it is assumed that the upper range of lead concentrations resulting from natural and area-wide anthropogenic sources is about 400 mg/Kg, then the mean of all samples that are less than 400 mg/Kg is about 195 mg/Kg.

- There is only a weak correlation between the occurrence of elevated lead and elevated arsenic in soil, suggesting that the main sources of lead and the main sources of arsenic in yard soil are not likely to be the same.

- Some residential properties contain arsenic at concentrations substantially higher than the expected natural levels. Properties with elevated levels of arsenic occur at widely scattered locations across the site with no clear spatial pattern. At an affected property, the contamination appears to be distributed across the yard area, with a fairly clear boundary between the affected property and the adjacent property. The chemical form of arsenic is predominantly arsenic trioxide.

- Lead also occurs at elevated levels in soil at some residential properties. Elevations occur in all neighborhoods of the site, but levels tend to be higher on the western part of the site than the eastern part.

- Lead was detected in paint at most locations where paint was sampled, with 130 out of 144 samples having values above 1 mg/cm^2. These data suggest that interior and/or exterior leaded paint might be a source of lead exposure in area children, either directly (by paint chip ingestion), or indirectly (by ingestion of dust or soil containing paint chips).

- Mean arsenic concentrations in surface soils in schools and parks range from below the method detection limit of 11 mg/Kg to 26 mg/Kg. The mean lead concentrations range from 67 to 256 mg/Kg.

- Elevated blood lead levels have been measured in children residing within the site. Soil is not likely to be the main source of elevated blood lead levels.

As discussed in Section 3, the RAOs and PRGs developed for the OU are:

RAOs for Arsenic in Soil

A. For residents of the VB/I70 site, prevent exposure to soil containing arsenic in levels predicted to result in an excess lifetime cancer risk associated with ingestion of soil and ingestion of home grown garden vegetables which exceeds 1×10^{-4} using reasonable maximum exposure assumptions.

B. For residents of the VB/I70 site, prevent exposure to soil containing arsenic in levels predicted to result in a chronic or sub-chronic hazard quotient associated with ingestion of soil and ingestion of home grown garden vegetables which exceeds 1 using reasonable maximum exposure assumptions.

C. For children with pica behavior who reside in the VB/I70 site, reduce the potential for exposures to arsenic in soil that result in acute effects.

PRG: At properties where remedial action of soil is necessary, the PRG for arsenic in soil is established as background. Background concentrations within the VB/I70 study area range from 8 to 15 mg/Kg as the arithmetic mean concentration within a yard. This level of arsenic represents a cumulative lifetime cancer risk of 1×10^{-5} using RME assumptions in a residential scenario.

RAO for Lead in Soil

D. Limit exposure to lead in soil such that no more than 5 percent of young children (72 months or younger) who live within the VB/I70 site are at risk for blood lead levels higher than 10 ug/dL from such exposure.

PRG: At properties where remedial action of soil is necessary because soil is determined to be a source of lead exposure which exceeds EPA's objective, the PRG for lead in soil is established as background. The mean background concentration of lead in residential soil within the VB/I70 study area is approximately 195 mg/Kg.

To meet the requirements of the RAOs a range of GRAs is identified as follows:

- No action
- Institutional Controls
- Public Health Actions
- Containment
- Removal/Disposal
- Treatment

4.2 Extent of Soils with Lead or Arsenic Concentrations Above Preliminary Action Levels

Based on the RI Phase III database (i.e. properties that have been sampled), 635 properties currently have arsenic EPCs above 47 mg/Kg, 73 properties have arsenic EPCs above 240 mg/Kg, 1,303 properties have lead EPCs above 208 mg/Kg, and 73 properties have lead EPCs above 540 mg/Kg. Each of these property counts excludes 48 properties where soil has already been removed and includes 6 properties previously targeted for soil removal due to arsenic levels where access was denied. However, these values do not include the approximately 1,000 properties within the VB/I70 study area that were not sampled during the RI Phase III. If it is assumed that the ratio of properties with lead and arsenic EPCs above the preliminary action levels are the same in the approximately 1,000 unsampled properties, then it would be estimated that a total of 863 properties currently have arsenic EPCs above 47 mg/Kg, 113 properties have arsenic EPCs above 240 mg/Kg, 1,737 properties have lead EPCs above 208 mg/Kg, and 97 properties have lead EPCs above 540 mg/Kg. These property counts are summarized on Table 4-1.

4.3 Identification and Initial Screening of Remedial Technologies

In this section, remedial technologies and process options are identified and screened in accordance with procedures described in RI/FS guidance (EPA, 1988a). Remedial technologies and process options that pass the initial screening test are subjected to more rigorous evaluation of effectiveness, implementability, and relative cost in the final screening, as described in Section 4.4.

For the GRAs identified in Section 4.1, a range of potentially applicable remedial technologies and associated process options were identified as shown in Table 4-2. A description of the remedial technologies and process options are provided in the following subsections, along with the results of the initial screening. The purpose of the initial screening step is to eliminate remedial technologies that have no possibility of implementation for VB/I70 OU1. In accordance with RI/FS Guidance, the technical implementability of remedial technologies is judged during initial screening by the technical applicability to the specific OU conditions, including:

- Technical applicability to arsenic and lead, which are the COCs at the OU; and
- Technical applicability for remediation of residential soils at the concentrations of arsenic and lead present.

The results of the initial screening step are summarized on Table 4-3 and discussed in the following subsections.

4.3.1 No Action

No Action would entail performing no additional remedial activities in the OU. As discussed in Section 1.2, soil removal was performed at 48 properties during the recent removal actions at the site. The NCP requires that a No Action alternative be retained for detailed analysis for consideration as a baseline against which other alternatives can be compared.

4.3.2 Institutional Controls

Institutional Controls are non-engineering mechanisms that provide the means by which Federal, State and local governments or private parties can prevent or limit access to or use of contaminated environmental media, the use of areas impacted by COCs, and/or to ensure the integrity and maintenance of engineered remedial components. Institutional Controls may be applied on a stand-alone basis or implemented in conjunction with other response actions as part of an overall site remedy.

As shown in Table 4-2, land use controls were identified as being potentially applicable to the OU. Types of land use controls are: (1) local land use regulations (such as subdivision ordinances or zoning regulations implemented by local governments for the purpose of protecting the health, safety and general welfare of the people by limiting access); (2) easements created by a grant from a property owner to another party prohibiting the property owner from conducting certain activities that may have the potential to cause a health threat; and (3) restrictive covenants, which are written restrictions or requirements placed on the title to real property that pass with the property and bind both current and future owners of the property to prohibit activities which may have the potential to cause a health threat. Land use controls could be implementable at the site and therefore this remedial technology is carried forward for further evaluation.

4.3.3 Public Health Actions

Public health actions could entail a program targeting specific subpopulations at risk and/or specific behavior that could potentially cause higher exposure. Actions may include education, biomonitoring and environmental sampling, public health referrals and engineering response to protect health.

4.3.3.1 Education

Education programs have been implemented at other similar sites to assist in managing risks. This type of program could be implemented at the VB/I70 site since the local county health department and communities have some of the necessary organizational structure already in place and therefore this technology is retained for further evaluation.

4.3.3.2 Biomonitoring

Biomonitoring programs (such as blood lead testing and urine arsenic screening) have been implemented successfully at other similar sites and would be appropriate at the VB/I70 site for identifying higher than normal exposures that result from RME behavior and/or sources other than soil, as well as for evaluation of the effectiveness of other remedial action engineering and response components. At the VB/I70 site, biomonitoring programs have been successfully implemented by EPA and CDPHE for targeted subpopulations. This technology is retained for further evaluation.

4.3.3.3 Environmental Sampling and Response

Environmental sampling and response activities could be implemented to address health risks identified by the biomonitoring program by accurately identifying sources of unacceptable exposure and addressing these sources. This technology is retained for further evaluation.

4.3.4 Containment

Containment actions entail isolating the COCs by physical means. Remedial technologies for containment are covering and surface control.

4.3.4.1 Covering

Containment of residential soils may be achieved by installation of engineered covers to prevent direct contact. There are a variety of available engineered cover designs, including simple soil, rock/gravel, geosynthetic, asphalt, concrete and multimedia (for example, soil-synthetic membrane, soil-synthetic membrane-clay caps, etc.). Covering may be applicable to the site conditions and therefore this remedial technology is retained for further evaluation.

4.3.4.2 Surface Control

Surface controls may include soil grading, vegetation or tilling. Soil grading typically entails contouring the ground surface to potentially reduce exposure. Vegetation consists of seeding appropriate grass, legume or shrub species to provide a stand of vegetation that will reduce erosion and stabilize soils. Tilling includes mechanically turning over and mixing of the upper soil column such that contaminant levels at the surface are reduced. These options are potentially applicable to the site conditions and are retained for further evaluation.

4.3.5 Removal/Disposal

4.3.5.1 Removal

Conventional open cut excavation of shallow soils is typically conducted by means of earthmoving equipment, including backhoes, wheel loaders, and scrapers. This technology was used during the previous removal action at the site and is therefore applicable to site conditions and retained for further evaluation.

4.3.5.2 Disposal

Excavated soils may be disposed at an appropriate landfill or other facility. Disposal was used during the previous removal action and therefore is applicable to site conditions and is retained for further evaluation.

4.3.5.3 Recycle/Reuse

Recycle or reuse may be a viable option for materials that have high concentrations of contaminants that can be processed to recover a salable product. However, because of the relatively low concentrations of lead and arsenic in residential soils and the lack of potential processing facilities in the region, this technology would not be applicable for the remediation of the OU soils and it is eliminated from further consideration.

4.3.6 Treatment

Treatment technologies involve physical, thermal, chemical or biological processes that can destroy contaminants, reduce the total mass of contaminants, reduce contaminant mobility and/or bioavailability, and/or reduce the total volume of contaminated soils. Treatment technologies may be performed on excavated soils (i.e., ex-situ) or in-place soils (in-situ). At this initial screening step the relative advantages or difficulties associated with performing any treatment option in-situ or ex-situ are not evaluated, rather the general applicability of the general technology approach is considered. More detailed evaluation of technologies that survive the initial screening step is performed in Section 4.4.

4.3.6.1 Physical

Physical treatment options entail processes that separate contaminants from the soil by physical means (for example soil washing) or reduce the availability of the contaminants by physically binding them to the soil or treatment matrix (for example, stabilization/fixation). These types of processes are potentially applicable to residential soils and this remedial technology is therefore retained for further evaluation.

4.3.6.2 Thermal

Thermal treatment processes typically entail the destruction of organic contaminants by use of high temperatures (for example, incineration). However, because the site COCs are inorganic and are not destroyed by high temperatures, this technology would not be appropriate. Vitrification is a thermal treatment process that immobilizes inorganic compounds and destroys organic compounds by electrically heating and fusing the soil into a stable glass-like block. In-situ vitrification can be conducted by inserting electrodes directly into soils containing chemicals and applying electrical heat. In addition to the unproven status of the technology, the resulting vitrified soil would be a sterile soil, which would not be appropriate for remediation of residential yards.

In-situ thermal desorption consists of injecting steam directly into contaminated soil and collecting the condensed vapor after it has stripped organic compounds from the soil. In-situ thermal desorption is not a commercially demonstrated technology and its application is limited to volatile organic compounds.

Therefore, based on the above factors thermal treatment technologies would not be applicable to site conditions and are eliminated from further consideration.

4.3.6.3 Chemical

Chemical treatment entails destruction or reduction in availability of contaminants of concern through chemical reaction. Potential process options include oxidation/reduction, neutralization, or reaction with siliceous chemicals. These processes may be applicable to residential soils containing lead and arsenic and therefore chemical treatment is retained for further evaluation.

4.3.6.4 Biological

Biological treatment consists of enhancing the biological degradation of organic constituents by microorganisms. Since organic constituents are not of concern for residential soils at the site, this technology is not applicable and is eliminated from further consideration.

4.4 Final Screening of Remedial Technologies and Process Options

This section provides a description of the final screening of remedial technologies and associated process options. Remedial technologies and process options that survived the initial screening test described in the previous subsection are subjected to more rigorous evaluation in the final screening. In accordance with the RI/FS Guidance, medium-specific and location-specific technologies and process options are evaluated during final screening for their anticipated effectiveness, potential implementability, and order-of-magnitude estimates of relative cost. Process options for each technology are screened relative to each other on the basis of the above-stated criteria. The goal of this screening step is to narrow the focus to a subset of options consisting of only the most viable remedial alternatives. Factors considered for each criterion are as follows.

- **Effectiveness Evaluation.** The primary measure of effectiveness used in this evaluation is the degree to which a process option would contribute to achievement of the RAOs. Other effectiveness criteria specified by the FS Guidance include:
  - The capacity to handle the estimated areas or volumes of soils to be remediated;
  - Potential impacts to human health and the environment during the construction and implementation phase; and
  - The demonstrated reliability with respect to the COCs and conditions at the site.

Process options are also evaluated on the basis of effectiveness relative to other processes within the same technology type.

- **Implementability Evaluation.** Technically inapplicable and infeasible remedial technologies were eliminated from further consideration during the initial screening process described in the previous section. The technical and administrative feasibility of implementing a technology or process option is further considered during this final evaluation. Some of the administrative and technical aspects of a technology's implementability considered during this screening step include the following:

    - Anticipated community acceptance (in particular compatibility with residential yard use);

    - Availability of treatment, storage, and disposal services; and

    - The availability of resources to implement the technology.

- **Cost Evaluation.** The cost analysis is performed on the basis of information contained in EPA guidance documents, experience in costing similar projects, independent estimates, and engineering judgment. In accordance with the RI/FS Guidance, those process options providing similar effectiveness at significantly higher relative costs are eliminated from further consideration at this screening level. Relative cost evaluations between process options were only performed where they were necessary to facilitate the screening process. Detailed costs are provided for all retained options in Section 6.0.

The results of the final screening step for remedial technologies and process options are summarized on Table 4-4 and discussed in the following subsections.

4.4.1 No Action

No Action would entail performing no additional remedial activities in the OU. The NCP requires that a No Action alternative be retained as a baseline against which other alternatives can be compared in the detailed analysis and therefore this alternative is retained without screening.

4.4.2 Institutional Controls

Institutional Controls are non-engineering mechanisms that provide the means by which Federal, State and local governments or private parties can prevent or limit access to or use of contaminated environmental media, the use of areas impacted by COCs, and/or to ensure the integrity and maintenance of engineered remedial components. Institutional Controls may be applied on a stand-alone basis or implemented in conjunction with other response actions as part of an overall site remedy.

As shown in Table 4-2, land use controls were identified as being potentially applicable to the OU. Types of land use controls are: (1) local land use regulations (such as subdivision ordinances or zoning regulations implemented by local governments for the purpose of protecting the health, safety and general welfare of the people by limiting access); (2) easements created by a grant from a property owner to another party prohibiting the property owner from conducting certain activities that may have the potential to cause a health threat; and (3) restrictive covenants, which are written restrictions or requirements placed on the title to real property that pass with the property and bind both current and future owners of the property to prohibit activities which may have the potential to cause a health threat.

Land use controls are typically used in situations where current use is something other than residential and RAOs are developed to protect workers or visitors. Controls that prevent future residential land use can, in these situations, achieve the requirements of risk-based RAOs. Because VB/I70 OU1 is already residential, in order to achieve the RAOs, land use controls would need to restrict common activities that are associated with incidental exposure to soil and dust. It is likely that land use controls would not be effective in protecting human health and would not be accepted by the community and therefore this remedial technology is eliminated from further consideration.

4.4.3 Public Health Actions

Public health actions could entail a program targeting site residents potentially at risk, and could include education, biomonitoring and environmental sampling and response components.

4.4.3.1 Education

Education programs have been implemented at other similar sites to assist in preventing or minimizing exposures that are associated with specific subpopulations and activities, very infrequent, or suspected to be from multiple sources. Education programs can be used to raise overall community awareness of the potential health risks, inform the community about behaviors and activities that result in exposure, inform the community on how to reduce or prevent exposures, and provide information about public health resources. This type of program could be an effective component of an overall remedy for the OU. It would be readily implementable at the VB/I70 site as there are established community organizations, such as neighborhood associations and environmental coalitions that could assist in the distribution of educational materials. Also, State and local City and County agencies have lead awareness and intervention programs already in place. The addition of educational programs specific to soil pica behavior and arsenic would be easily added since the organizational structure is in place. This option is retained for the development of remedial alternatives.

4.4.3.2 Biomonitoring

Voluntary biomonitoring programs (such as blood lead testing and urine arsenic screening) have been implemented successfully at other similar sites and would be appropriate at the VB/I70 site for identifying higher than normal exposures that result from RME behavior and/or sources other than soil, as well as for evaluation of the effectiveness of other remedial action engineering and response components. Consistent with the RAOs, the biomonitoring program for the VB/I70 site would offer blood lead testing for young children (6 to 72 months old) and urine arsenic screening for children along with health-based, case-management and follow-up services (physician referrals, referral to environmental sampling/response program, etc.). An active recruitment and incentive program would also be implemented to ensure that resident participation is sufficient to evaluate the performance of the remedy in achieving the RAOs, especially with respect to blood lead monitoring for young children since elevated blood lead levels have been measured in children residing within the site. Predicted exposures to arsenic in soil associated with soil pica behavior in children are uncertain and likely overestimate true exposures. Testing would be offered at least annually and more often if necessary; all families with young children would be encouraged to participate in the biomonitoring program annually. This type of program would be readily implementable due to the presence of established community organizations, as well as State and local City agencies, with lead awareness and intervention programs. The addition of arsenic testing would be easily added since the organizational structure is in place. This option is retained for the development of remedial alternatives.

4.4.3.3 Environmental Sampling and Response

The environmental sampling and response program would provide soil sampling at properties not addressed through previous sampling efforts or more intensive sampling at properties previously sampled where biomonitoring indicates higher than normal exposure, as well as environmental remediation and response services if required for sampled properties to protect the health of present or future residents. Sampling of other potential sources of lead (i.e., lead paint, drinking water) would also be performed. Information gathering would also include a questionnaire to evaluate behaviors of current resident children that could result in exposure to lead or arsenic. Data collected through a biomonitoring program can be used to demonstrate the performance of a remedy in reducing risks from arsenic and lead in soil and meeting the RAOs. If the remedy's performance in meeting the RAOs (or other predefined performance standards) is not demonstrated over time, then alternative remedies would be considered and potentially implemented to meet those objectives. This option is retained for development of remedial alternatives.

4.4.4 Containment

Containment actions entail isolating the COCs by physical means. Remedial technologies for containment are covering and surface control.

4.4.4.1 Covering

Engineered covers are commonly used to prevent direct contact with soils containing COCs above levels of concern.

Rock

Engineered rock covers minimize erosion and reduce physical exposure to contaminated soils. Engineered rock covers provide some advantages, such as being low maintenance (e.g., railroad bed or dedicated road or trail base) and durable. However, they are not compatible with residential yard uses and have a higher cost than soil covers and are therefore eliminated from further consideration.

Geosynthetic

Geosynthetic covers include polymer or clay membranes that are typically used to reduce infiltration of surface water. They would not be effective at preventing direct contact and would not be compatible with residential yard use and this process option is therefore eliminated from further consideration.

Asphalt and Concrete Covers

Asphalt and concrete covers would be effective in preventing contact with soils containing levels of arsenic or lead which represent a potential risk. However, they would not be implementable because they are not compatible with general residential yard use for the site conditions where contaminated soil is present in accessible areas such as lawns, flower beds, etc. Therefore, asphalt and concrete covers are eliminated from further consideration.

Multimedia Covers

Multi-layered, multimedia covers, including soil-synthetic membrane-clay caps, are relatively costly and provide no additional advantages in preventing direct contact compared to the soil cover described below. The design of multi-layered covers generally adopts a two to three-layered system consisting of an upper layer that will support vegetation and provide adequate drainage, underlain by a lower permeability layer. The upper layer or layers usually consist of cover soil with a subjacent drainage material if needed. These types of covers can be used to reduce infiltration, but provide no additional benefits for the conditions at the VB/I70 site. They would also not be compatible with residential yard use. Therefore multimedia covers are eliminated from further consideration.

Soil Covers

Soil covers have been used effectively in numerous residential remediation projects, in conjunction with removal of surface soils to allow for pre-remediation surface elevations and grades to be maintained. They are used when contamination is relatively deep, such as in situations where houses were built on waste piles. Soil covers are compatible with the use of residential yards and have a lower cost than other cover process options described above. A soil cover would also reduce the risks associated with exposure to solid media via dermal contact, ingestion and inhalation. However, at the VB/I70 site contamination is confined to surface and near-surface yard soils. The removal activities required to be implemented to allow for installation of a soil cover would address contamination issues and therefore soil cover as a containment option would not be effective for site conditions and this process option is eliminated from further consideration.

4.4.4.2 Surface Control

Surface controls may include soil grading, vegetation or tilling.

Soil Grading

Soil grading typically entails contouring the ground surface to potentially to reduce exposure. It can be used in industrial/mining situations such as for tailings piles. However, it would notbe effective for residential yards, because it would not prevent direct contact with contaminated soils. In addition, it would be difficult to implement, because post-remediation grades must be close to pre-remediation ones to allow for the appropriate yard use. Therefore, this process option is eliminated from further consideration.

Vegetation

Vegetation consists of seeding appropriate grass, legume or shrub species to provide a stand of vegetation that will reduce erosion and stabilize soils. It can be used to reduce potential exposures to contaminated soils in situations where dust is created by activities on exposed soils. This would not be effective as a stand-alone option at the VB/I70 site, but could be used as a component of a tilling/restoration alternative and is therefore retained for the development of remedial alternatives.

Tilling

Tilling includes mechanically turning over and mixing the upper soil column such that contaminant levels at the surface are reduced. Tilling with revegetation is a viable stand-alone alternative in cases where contaminant concentrations are relatively close to cleanup goal levels. It would not be effective in situations where similar levels and/or relatively high levels of contamination exist throughout the tilling depth. For the purposes of FS alternative evaluation, it was concluded that hand rototilling would be the most consistently practical option (larger mechanical tillers may be usable in large open areas with easy access, but because this would not consistently be the case for the yards at VB/I70 OU1). Hand rototilling typically achieves about a 6 inch tilling depth.

A screening evaluation of tilling as a stand-alone method for remediating properties in the VB/I70 OU1 was performed. The purpose of tilling is to reduce the surface contamination below the action levels and as close to the PRGs as possible. Data generated by the intensive sampling of 8 properties during the Residential Risk-Based Sampling Investigation (see Section 2.1) were used to evaluate the potential effect of tilling on lead concentrations in surface soils. The investigation generated lead concentrations at 2-inch intervals to a depth of 12 inches. In the evaluation, for each property the lead concentration remaining after tilling was estimated by averaging all concentrations within the tilling depth (i.e., assumed all soil is completely mixed). As shown on Table 4-5, this analysis estimated that on average lead concentrations at the surface would be reduced by 23% by 6 inch tilling and 39% by 12 inch tilling. For the four properties with surface lead concentrations above 540 mg/Kg, these reductions were estimated at 31% for 6 inch tilling and 49% for 12 inch tilling. The Phase III data show the highest average surface concentrations of lead in any property where soil has not already been removed are around 1,130 mg/Kg. If tilling were to result in a 31% reduction, this would leave a surface concentration of approximately 790 mg/Kg, which would not meet the requirements of the RAOs. Tilling is therefore not retained as a stand-alone option in the development of remedial alternatives. However, tilling would provide the opportunity to physically mix surface soils with treatment agents, which potentially would reduce the lead bioavailability and thus provide protection of human health. Tilling is therefore carried forward for development of remedial alternatives in conjunction with treatment.

4.4.5 Removal/Disposal

4.4.5.1 Removal

Conventional open cut excavation of shallow soils is typically conducted by means of earthmoving equipment, including backhoes, wheel loaders, and scrapers. This technology was effectively used during the previous removal action at the site and is therefore applicable to site conditions and retained for development of remedial alternatives.

4.4.5.2 Disposal

Onsite

There are no viable disposal facilities within the site boundaries and therefore onsite disposal could not be implemented and this option is eliminated from further consideration.

Offsite

Excavated soils may be disposed offsite at an appropriate landfill or other facility. Offsite disposal would be an effective method of preventing the potential for exposure to contaminated surface soils at the site. Offsite disposal was used during the previous removal action and therefore is applicable to site conditions and is retained for further evaluation.

4.4.6 Treatment

Treatment technologies that survived the initial screening step described in Section 4.3 involve physical or chemical processes that can reduce the total mass of contaminants, reduce contaminant mobility and/or bioavailability, and/or reduce the total volume of contaminated soils.

4.4.6.1 Physical

Physical treatment options entail processes that separate contaminants from the soil by physical means (for example, soil washing) or reduce the availability of the contaminants by physically binding them to the soil or treatment matrix (for example, stabilization/fixation).

Stabilization/Fixation

In general, stabilization/fixation processes involve mixture of the material of interest with other materials to immobilize the chemical of interest. Immobilization is typically achieved primarily through a physical property. Overall, stabilization/fixation treatment technologies have low effectiveness for arsenic (Hydrometrics, 1996), however, they can be effective for lead. Processes such as mixing soil with Portland cement have been used successfully to treat soils containing lead in industrial settings; however, the resultant cement/soil matrix would not be compatible with residential yard use and so could not be used for VB/I70 OU1. A process option that appears to have potential for use in a residential yard setting is addition of phosphate to reduce the lead mobility and bioavailability. This would be compatible with residential yard use, because it is a common component of fertilizers and is being evaluated for use in remediation of lead contaminated soils at other sites. This process option is retained for further evaluation in the development of remedial alternatives.

Dewatering

Dewatering technologies are typically used to reduce the water content of sediments or sludges. These types of materials are not the focus of remedial actions at the site and therefore this option is eliminated from further consideration in the development of remedial alternatives.

Aeration.

Aeration typically entails passing an air stream through the materials undergoing treatment to oxidize or volatilize compounds of concern. This type of technology is not applicable to either arsenic or lead and therefore this process option is eliminated from further consideration in the development of remedial alternatives.

Soil Washing

Soil washing typically entails passing extractant solvents through affected soil. Solvents may include water, acids or bases, and chelating agents. This option would be not be effective for remediation of residential soils. Lead and arsenic concentrations are relatively low and extractant solutions would have to be compatible with residential soil uses. This option would also be difficult to implement in a residential setting due to the equipment required. Therefore, this option is eliminated from further consideration in the development of remedial alternatives.

Acid Leach Washing

Acid leach washing has been tested for soil and residual lead smelter materials containing relatively high concentrations of arsenic (Hydrometrics, 1992). These tests demonstrated modest reductions (40 to 60%) in soil arsenic concentrations in oversized fractions of soil greater than 200 micrometers in size. Several technical difficulties were encountered with this technology, including high post-treatment leachability of treated soils due to residual acids, low effectiveness in washing the entire soil mass, large water requirements, difficult recovery of wash fluids and sludges, difficulty in treating the fine grain fraction of soil, and requirements for handling, treatment and/or disposal of wash fluids and sludges (Hydrometrics, 1996). It would not be effective for the relatively low concentrations of lead and arsenic found in VB/I70 OU1 soils and also would be difficult to implement in a residential setting due to the equipment required. This technology is therefore eliminated from further consideration in the development of remedial alternatives.

Chelation

Chelation is a treatment process in which a chelating chemical is used to solubilize metals from soil. Chelating agents are commercially available, and can be chosen for their affinity for particular metals. However, this treatment would not be effective for the relatively low concentrations of lead and arsenic at the site and would be difficult to implement in a residential setting. It is therefore eliminated from further consideration in the development of remedial alternatives.

Electro-Osmosis

Electro-osmosis decontamination concentrates or separates ionic species by exposing the material to an electric field. Heavy metals in the soils can be leached or precipitated out of solution by electrolysis, oxidation and reduction reactions, or ionic migration. This method has been examined on a laboratory scale and found to result in minimal arsenic reduction in soils (Hydrometrics, 1996). The testing, on soils from a similar smelter site, found that electro-osmosis was only effective on fine-grained soils of low permeability. As with other treatment options it would also be physically difficult to implement in a residential setting and therefore this option is eliminated from further consideration in the development of remedial alternatives.

4.4.6.2 Chemical

Chemical treatment entails destruction or reduction in availability of COCs through chemical reaction. Potential process options include oxidation/reduction, neutralization, or reaction with siliceous chemicals.

Oxidation/reduction

Chemical oxidation involves the addition of chemical agents, such as ozone, chlorine, and hydrogen peroxide, often in the presence of an ultraviolet light energy source, which can oxidize compounds to destroy them, or convert them to a less toxic form. Reduction is a similar process, except that reagents such as metabisulfite are added to reduce compounds to less toxic forms. Oxidation reactions are effective in detoxifying liquids containing organics and certain inorganics (such as cyanide, sulfide and nitrite). Reduction reactions are effective for detoxifying liquids containing certain inorganics, such as hexavalent chromium. However, these processes are not effective for arsenic and lead and are eliminated from further consideration.

Neutralization

Chemical neutralization could be used to reduce the mobility of arsenic in either highly acidic or basic soils or the mobility of lead in highly acidic soils. However, residential soils at the site are near neutral and therefore this process would not be effective in reducing mobility of lead or arsenic and it is eliminated from further consideration.

Siliceous Chemicals

Siliceous chemicals can be used to fix and solidify polyvalent metal and metalloid ions, such as arsenic, via reactions between silicates and positively charged metals. Several siliceous processes are commercially available and have been previously demonstrated to be effective for certain materials. However, the effectiveness of these processes is heavily dependent on the completeness of mixing. This option would be difficult to implement in a residential setting due to the required equipment and would leave soils that would not be compatible with residential yard use. Therefore this option is eliminated from further consideration in the development of remedial alternatives.

5.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

This section provides a detailed description of the remedial action alternatives developed for VB/I70 OU1. The alternatives are developed by assembling logical combinations of remedial technologies and process options, which survived the screening process described in Section 4.0. The comprehensive remedial alternatives, which are summarized on Table 5-1, are as follows:

- Alternative 1 - No Action
- Alternative 2 – Community Health Program, Tilling/Treatment (Lead), Targeted Removal and Disposal (Arsenic)
- Alternative 3 – Community Health Program, Targeted Removal and Disposal
- Alternative 4 – Community Health Program, Expanded Removal and Disposal
- Alternative 5 – Removal and Disposal

Detailed descriptions of the alternatives are provided in the following subsections.

5.1 Alternative 1 - No Action

The no action alternative provides a baseline for the evaluation of other alternatives in accordance with the NCP. No additional protective or remediation measures would be taken for the no-action option. As noted previously, soils have been removed from 48 residential properties at the site.

In general, the no-action alternative may be viable if constituent concentrations are below remedial action levels. This alternative may also be appropriate for materials or soils, which do not pose unacceptable risks to human health or the environment, if implementation of remedial actions would create a greater risk, or if the cost of remediation is excessive when compared to the risk reduction.

5.2 Alternative 2 – Community Health Program, Tilling/Treatment (Lead), Targeted Removal and Disposal (Arsenic)

Alternative 2 contains the following principal components:

Implementation of a Community Health Program

The community health program alternative for the VBI70 site would be composed of two separate (but partially overlapping) elements: the first designed to address risks to area children from lead in un-remediated soils above the preliminary action level of 208 mg/Kg; and the second designed to address risks to area children from pica ingestion of arsenic in un-remediated soils above the preliminary action level of 47 mg/Kg. Each of these two main elements of the program is described below. Participation in one or both elements of the program would be strictly voluntary, and there would be no charge to eligible residents and property owners for any of the services offered by the community health program.

Public Health Program To Reduce Risks From Lead

The program for reduction of lead risks is intended to be general. That is, it is intended to assess risks from lead from any and all potential sources of exposure, with response actions tailored to address the different types of exposure source that may be identified. The lead program will consist of three main elements:

1) Community and individual education about potential pathways of exposure to lead, and the potential health consequences of excessive lead exposure.

2) A biomonitoring program by which any child (up to 72 months old) may be tested to evaluate actual exposures.

3) A program to respond to any observed lead exposures that are outside the normal range. This will include any necessary follow-up sampling, analysis, and investigation to help identify the likely source of exposure, and to implement an appropriate response that will help reduce the exposure.

These three components are described in greater detail below.

1. Education and Outreach Program

The education and outreach program will provide residents with information on two basic topics: 1) the possible health effects from excessive exposure to lead, and 2) strategies for reducing exposure and risk from lead in various sources that may exist in and around residents' homes. This education may take the form of presentations to parents at schools or community meetings, along with distribution of fliers, handouts, fact sheets, etc. The education and outreach program may also include providing equipment and supplies that may help reduce exposures from some media (e.g., discounted cleaning supplies, a HEPA-vacuum loan program, etc), along with referrals to outside lead-based paint inspection and abatement programs or other public health services available to residents within the site.

Educational and outreach services would be available to all residents within the site for as long as the remedy operates.

Educational interventions similar to this program have been effective in reducing children's blood-lead concentrations, either alone (Kimbrough et al. 1994, USEPA 1996, LCDH and UC 1993, USEPA 1998) or in combination with dust control programs (Rhoades et al., 1997; Lioy et al., 1998). These interventions have also been effective in reducing residential dust-lead loadings (Lanphear 1995, 1996, and Copley 1995). A more detailed summary of data on the efficacy of education-based programs for lead is presented in Appendix A.

2. Biomonitoring Program

The biomonitoring program will offer blood lead testing for young children (6 to 72 months old). An active recruitment program will be implemented to ensure that the data are adequate to evaluate the overall performance of the remedy in achieving the RAO for lead. The program will be organized to emphasize sampling once per year, usually in the late summer (before the start of the school season) and to coincide with other public health activities already being implemented (e.g., immunization clinics).

However, any child with concerns over potential excess lead exposures may have blood lead testing performed at any time throughout the year.

These biomonitoring services will be available to all residents within site for as long as the remedy operates.

The purpose of these biomonitoring activities is to identify children residing within the site who are experiencing exposures to lead that are higher than typical. If any individuals are identified with elevated exposures, this will be followed up by response activities as described below.

3. *Response Program*

This element of the program will ensure there is an appropriate response at any property where information from the biomonitoring program indicates a child has an excessive exposure to lead. If the exposure level of an individual is judged to be of potential clinical relevance, the first response will be a prompt referral to a physician for further evaluation and treatment, as necessary. In all cases, this referral step will be followed by an investigation into the likely source of the exposure. This investigation will seek to assess not only soil-related exposures, but exposures from other (non-soil) sources as well (paint, water, cookware, other lead-containing items, etc.). If soil is judged to be the most likely source of exposure, a series of alternative actions will be evaluated to identify the most effective way to reduce that exposure. These will include a wide range of potential alternatives, including such things as education, sodding or capping of contaminated soil, tilling/treatment, etc. If exterior paint is the source of lead contamination in soil, remediation of the paint may be considered. If the main source is judged to be non-soil related, responses may include things such as education and counseling, or referral to environmental sampling/response programs offered by other agencies, as appropriate.

Public Health Program To Reduce Risks From Pica Ingestion Of Arsenic

Life-time chronic cancer and non-cancer risks from incidental ingestion of arsenic in soil are addressed by the soil removal/disposal component of this remedial alternative. The public health alternative for arsenic is designed to focus specifically on the potential risks by young children with soil pica behavior. The program for arsenic will consist of three main elements:

1) Community and individual education about identification and potential hazards of pica behavior and the potential health consequences of excessive acute oral exposure to arsenic.

2) A biomonitoring program by which any child may be tested to evaluate actual soil pica exposure to arsenic.

3) A program to respond to any observed inorganic arsenic exposures that are outside the normal range. This will include any necessary follow-up sampling, analysis, and investigation to help identify the likely source of exposure, and to implement an appropriate response that will help reduce the exposure.

These three components are described in greater detail below.

1. Education and Outreach Program

The education and outreach program will provide residents with information on two basic topics: 1) the possible health risks from pica ingestion of soil, including the potential effects from excessive acute oral exposure to arsenic, and 2) strategies for identifying and reducing pica behavior in children. This education may take the form of presentations to parents at schools or community meetings, along with distribution of fliers, handouts, fact sheets, etc. The health education component would be intended to raise awareness of this behavior and would encourage parents to have their children screened if they observe or suspect soil pica behavior.

Educational and outreach services would be available to all residents within the site for as long as the remedy operates.

No information was located on the efficacy of education programs intended to reduce pica behavior in children. However, there are many examples of public education programs intended to make people aware of the potential health risks of certain behaviors (smoking, drinking, use of drugs, unprotected sex, etc), including programs aimed at parental monitoring and intervention in behaviors that are hazardous in their children (depression, drug use, etc). Based on these other programs, it is expected that a program aimed at reduction of soil pica behavior would be effective.

2. *Biomonitoring Program*

The biomonitoring program will offer urinary arsenic testing for inorganic arsenic for young children (6 to 72 months old). An active recruitment program would be implemented to ensure that participation is sufficient to support an evaluation of the overall performance of the remedy in achieving the RAO for exposures to arsenic in soil that result in acute effects due to pica behavior. The program will be organized to emphasize routine urinary arsenic sampling once per year, usually in the late summer (before the start of the school season). This would be performed concomitant with the annual blood lead monitoring described above. However, because pica behavior might occur at any time, and because urinary arsenic levels are likely to elevated for only a few days following exposure, any resident with concerns over potential excess exposure of a child to arsenic in soil may have urinary arsenic testing done at any time throughout the year.

These biomonitoring services would available to all residents within site for as long as the remedy operates.

The purpose of these biomonitoring activities is to obtain information on the normal range of inorganic arsenic in urine in area children, and to obtain preliminary estimates of the frequency and magnitude of arsenic exposures that may result from pica behavior. If any individuals are identified with elevated exposures, this will be followed up by response activities as described below.

3. Response Program

This element of the program will ensure there is an appropriate response at any property where information from the biomonitoring program indicates a child has an excessive exposure to inorganic arsenic. If the exposure level of an individual is judged to be of potential clinical relevance, the first response will be a prompt referral to a physician for further evaluation and treatment, as necessary. In all cases, this referral step will be followed by an investigation into the likely source of the exposure. This investigation will seek to assess not only soil-related exposures, but exposures from other (non-soil) sources as well. If soil is judged to be the most likely source of exposure, a series of alternative actions will be evaluated to identify the most effective way to reduce that exposure. These will include a wide range of potential alternatives, including such things as education, sodding or capping, soil removal, etc. If the main source is judged to be non-soil related, responses may include things such as education and counseling, or referral to environmental sampling/response programs offered by other agencies, as appropriate.

Soil Tilling/Treatment

In yards with lead EPCs greater than 540 mg/Kg and arsenic EPCs below 240 mg/Kg, surface soils would be tilled to a depth of 6 inches and treated with phosphate. Pre-remediation yard features would then be restored. Based on RI data, it is estimated that this would occur at a total of 89 residential properties within the entire site (8 of the properties with lead EPCs above 540 mg/Kg also have arsenic EPCs above 240 mg/Kg and would therefore be remediated by soil removal). This value includes an estimate for the properties within the site that have not yet been sampled. The locations of properties where lead EPCs have been measured above 540 mg/Kg are shown on Figure 5-1.

Soil Removal

In yards with arsenic EPCs greater than 240 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil containing arsenic and lead below PRGs, and pre-remediation yard features restored. Based on RI data, it is estimated that this would occur at a total of 113 residential properties within the site boundaries (including properties yet to be sampled). The locations of properties where arsenic EPCs have been measured above 240 mg/Kg are shown on Figure 5-1.

On-Going Soil Sampling Program

To date, EPA has sampled the soil at approximately 75% of the residential properties within the VBI70 site boundary. Because the spatial pattern of lead and arsenic contamination is variable between properties, it is not possible to assess potential risks at a specific property without data from that property. Therefore, upon request from the owner or current resident (if access is granted by the owner), EPA will provide a program of on-going testing for lead and arsenic in soil at any residential property within the site boundaries that has not already been adequately tested. If the lead EPC exceeds 540 mg/Kg and the arsenic EPC is below 240 mg/Kg, soil at the property would be tilled and treated with phosphate. If the arsenic EPC exceeds 240 mg/Kg, soil would be removed and disposed offsite. This sampling program will operate for as long as the remedy operates.

5.3 Alternative 3 – Community Health Program, Targeted Removal and Disposal

Alternative 3 would contain the following principal components:

Implementation of a Community Health Program

Implementation of a community health program, identical to the one described for Alternative 2, except that potential future response actions would include soil removal and offsite disposal.

Soil Removal

In yards with arsenic EPCs greater than 240 mg/Kg or with lead EPCs above 540 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil containing arsenic and lead below the PRGs, and pre-remediation yard features restored. Based on RI data, it is estimated that this would occur at a total of 202 residential properties (105 properties for arsenic only, 8 for both arsenic and lead, and 89 for lead only). The locations of properties where lead or arsenic EPCs have been measured above 540 mg/Kg or 240 mg/Kg, respectively, are shown on Figure 5-1.

On-Going Soil Sampling Program

Identical to the program described under Alternative 2, upon request from the owner or current resident (if access is granted by the owner), EPA will provide a program of on-going testing for lead and arsenic in soil at any residential property within the site boundaries that has not already been adequately tested. Under Alternative 3, if the lead EPC exceeds 540 mg/Kg or the arsenic EPC exceeds 240 mg/Kg, soil would be removed and disposed offsite. This sampling program will operate for as long as the remedy operates.

5.4 Alternative 4 – Community Health Program, Expanded Removal and Disposal

Alternative 4 was developed in response to comments from the State of Colorado on the draft FS report (see Appendix D). The State proposed that remedial action be implemented where arsenic EPCs were in the range 42 mg/Kg to 128 mg/Kg to protect residents from predicted (point estimates) cancer risks in the 3E-5 to 8E-5 range. EPA selected a preliminary action level of 128 mg/Kg arsenic for this alternative to be evaluated in the FS process. Alternative 4 contains the following principal components:

Implementation of a Community Health Program

Implementation of a community health program identical to the one described for Alternative 3.

Soil Removal

In yards with arsenic EPCs greater than 128 mg/Kg or with lead EPCs above 540 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil containing arsenic and lead below PRGs, and pre-remediation yard features restored. Based on RI data, it is estimated that this would occur at a total of 403 residential properties (306 properties for arsenic only, 31 for both arsenic and lead, and 66 for lead only). The locations of properties where lead or arsenic EPCs have been measured above 540 mg/Kg or 128 mg/Kg, respectively, are shown on Figure 5-1.

On-Going Soil Sampling Program

Identical to the program described under Alternative 2, upon request from the owner or current resident (if access is granted by the owner), EPA will provide a program of on-going testing for lead and arsenic in soil at any residential property within the site boundaries that has not already been adequately tested. Under Alternative 3, if the lead EPC exceeds 540 mg/Kg or the arsenic EPC exceeds 128 mg/Kg, soil would be removed and disposed offsite. This sampling program will operate for as long as the remedy operates.

5.5 Alternative 5 – Removal and Disposal

Alternative 5 would contain the following principal components:

Soil Removal

In yards with arsenic EPCs greater than 47 mg/Kg or with lead EPCs above 208 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil containing arsenic and lead below PRGs, and pre-remediation yard features restored. This alternative would also include systematic sampling of the properties that were not sampled during the RI and soil removal at locations where lead or arsenic levels exceeded action levels.

Based on RI data, it is estimated that soil removal would occur at a total of 1,579 residential properties that were sampled during the RI (about 3,000 properties total were sampled; removals would be required at 276 properties for arsenic only, 944 for lead only and 359 for both lead and arsenic). For the purposes of FS evaluation it is assumed that the proportion of required removals would be the same in the unsampled properties as the previously sampled properties. Based on this approach it is estimated that soil removal would be required at 2,122 properties (384 properties for arsenic only, 1,259 for lead only and 479 for both arsenic and lead).

6.0 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section provides a detailed analysis of the remedial alternatives developed in Section 5. The alternatives are evaluated against the threshold and primary balancing criteria specified in the NCP and the FS Guidance (EPA, 1988a) to ensure that the selected remedial alternative will: protect human health and the environment; comply with or include a waiver of ARARs; be cost-effective; utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and address the statutory preference for treatment as a principal element. The modifying criteria of State and Community acceptance will be addressed by EPA after this FS is completed and prior to the finalization of the ROD, and will be based on comments received by EPA during a public comment period.

The nine FS evaluation criteria specified in the NCP are:

- Threshold Criteria
  - Overall Protection of Human Health and the Environment
  - Compliance with ARARs
- Primary Balancing Criteria
  - Short-Term Effectiveness
  - Long-Term Effectiveness and Permanence
  - Reduction of Toxicity, Mobility and Volume Through Treatment
  - Implementability
  - Cost
- Modifying Criteria
  - State Acceptance
  - Community Acceptance

These criteria are further defined by a set of sub criteria and factors described in the FS guidance (EPA, 1988a). While all nine criteria are important, they are weighed differently in the decision-making process depending on whether they describe a required level of performance (threshold criteria), provide for consideration of technical merits (primary balancing criteria), or involve the evaluation of non-EPA reviewers that may influence an EPA decision (modifying criteria). Explanations of the criteria, along with a generalized summary of these sub criteria and factors, are presented below.

Overall Protection of Human Health and the Environment

The evaluation of the overall protection of human health and the environment is based on a composite of factors assessed under the evaluation criteria. The criteria specifically considered are: short-term effectiveness, long-term effectiveness and permanence, and compliance with ARARs.

Compliance with ARARs

This evaluation analyzes the expected performance of each alternative in meeting the Federal and State standards, or limitations that constitute applicable or relevant and appropriate requirements (ARARs).

"Applicable Requirements" are those:

> Cleanup standards, standards of control, or other substantive environmental protection requirements, criteria or limitations promulgated under Federal environmental or State environmental or facility citing laws that specifically address a hazardous substance, pollutant or contaminant at a CERCLA site. Only those State standards that are identified by a State in a timely manner and that are more stringent than Federal requirements may be applicable. (NCP, 40 CFR § 300.5; Compliance with Other Laws Manual, p. 1-10.)

"Relevant and Appropriate Requirements" are those:

> Cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site so that their use is well suited to the particular site. Only those State standards that are identified in a timely manner and are more stringent than

Federal requirements may be relevant and appropriate. (NCP, 40 CFR § 300.5; Compliance with Other Laws Manual, p. 1-10.)

The following ARARs are considered in the evaluation of each alternative: chemical-specific (e.g., air quality standards); and action-specific (e.g., solid waste disposal standards). No location-specific ARARs were identified.

The NCP also requires the identification of other materials that, while not ARARs, may be useful in evaluating appropriate remediation goals or approaches. The "to be considered" (TBC) category generally is defined to include advisories, criteria, or guidance developed by EPA, other Federal agencies, or States that, while not legally binding requirements, may be useful in developing CERCLA remedies (see Section 300.400 (g)(3)). The NCP provides that, unlike ARARs, the use of TBCs is discretionary and that they are to be evaluated on an "as appropriate" basis. The NCP also confirms that the role of TBCs should not be tantamount to that of cleanup standards. Because TBCs are, by definition, neither promulgated nor enforceable, they do not have the same status under CERCLA as ARARs. TBCs may, however, be useful in evaluating protectiveness or how to carry out certain actions or requirements.

Short-Term Effectiveness

This evaluation criterion addresses the effects of the remedial alternative during the construction and implementation phase until the remedial objectives are met. Alternatives are evaluated with respect to their potential effects on human health and the environment during implementation of the remedial action. As specified in the CERCLA guidance, the short-term impacts of each remedial alternative are assessed considering the following factors:

- Short-term risks that might be posed to the community during implementation of remedial action;
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures;

- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and

- The time until protection is achieved.

Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness and permanence considers the risks remaining after the response objectives have been met. Factors considered, as appropriate, include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities.

- Adequacy and reliability of controls. This factor assesses the adequacy and suitability of controls, if any, that are used to manage untreated wastes that remain at the site. The long-term reliability of management controls for providing continued protection are also assessed, including the potential need to replace technical components of the alternative, and the potential exposure pathway and the risks, should the remedial action need replacement. In accordance with NCP requirements (40 CFR 300.430) and the FS Guidance (EPA, 1988a), the principal factors considered are:

    - The likelihood that the technologies will meet required process efficiencies or performance specifications;

    - The type of long-term management required;

    - Requirements for long-term monitoring;

    - Operation and maintenance functions;

    - Difficulties and uncertainties associated with long-term operation and maintenance;

    - The potential need for replacement of technical components;

    - The magnitude of the threats or risks should the remedial action need replacement;

    - The degree of confidence that controls can adequately handle potential problems; and

- The uncertainties associated with land disposal of residuals and untreated wastes.

Reduction of Toxicity, Mobility or Volume Through Treatment

The FS Guidance identifies the following factors to be considered in the evaluation of the degree to which remedial alternatives reduce the toxicity, mobility or volume of potentially hazardous materials through treatment:

- The treatment processes the alternatives employ and materials they will treat;
- The amount of hazardous materials that will be destroyed or treated, including how the principal threat(s) will be addressed;
- The degree of expected reduction in toxicity, mobility, or volume of the material due to treatment, measured as a percentage of reduction (or order of magnitude);
- The degree to which the treatment is irreversible;
- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents; and
- Whether the alternative would satisfy the statutory preference for treatment as a principal element of the remedy.

Implementability

This criterion addresses the technical and administrative feasibility of implementing each remedial alternative and the availability of various services and materials required during its implementation. As specified in the CERCLA guidance, the evaluation of implementability includes three categories of analysis and a total of nine factors:

- Technical Feasibility
  1. Ability to construct and operate the technology
  2. Reliability of the technology

3. Ease of undertaking additional remedial actions, if necessary
4. Ability to monitor the effectiveness of the remedy

- Administrative Feasibility

5. Ability to obtain approvals from other agencies
6. Coordination with other agencies

- Availability of Services and Materials

7. Availability of off-site treatment, storage and disposal services and capacity
8. Availability of necessary equipment and specialists
9. Availability of new technology under consideration

Cost

For each alternative, a -30 to +50 percent cost estimate is developed in accordance with procedures in the *Remedial Action Costing Procedures Manual*. Cost estimates for each alternative are based on conceptual engineering and design and are expressed in terms of 2001 dollars. The cost estimate for a remedial alternative consists of four principal elements:

- Remedial action cost – Remedial action cost consists of direct (construction), indirect (non-construction and overhead) costs, and costs associated with the implementation of community health program. Direct costs include the cost for equipment, labor, and materials incurred to develop, construct, and implement a remedial action. Indirect costs are expenditures for engineering, financial, and other services that are not actually a part of construction but are required to implement a remedial alternative. These items are included in the detailed cost analysis. As discussed in Appendix B, remedial action includes engineering actions (i.e., soil removal and/or tilling) and setting up and implementing a community health program.

- Operation and maintenance cost - Operation and maintenance (O&M) cost refers to post-remedial action cost items necessary to ensure the continued effectiveness of a remedial action. For the alternatives under consideration in this FS there are no O&M activities other than periodic review. Long-term actions, such as implementation of the community health program, are considered to be a component of remedial action.

- Cost for a 5-year review - Section 121(c) of CERCLA, as amended, states that a 5-year review of a remedial action is required if that remedial action results in hazardous constituents remaining on-site.

- Present worth analysis - This analysis is used to evaluate the remedial action and O&M costs of a remedial alternative based on its present worth. A present worth analysis compares expenditures for various alternatives where those expenditures occur over different time periods. By discounting all costs to a common base year, the costs for different remedial action alternatives can be compared based on a single cost figure for each alternative. The total present worth for a single alternative is equal to the full amount of all costs incurred through the end of the first year of operation (capital cost), plus the series of expenditures in following years reduced by the appropriate future value/present worth discount factor. This analysis allows the comparison of remedial alternatives on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. A discount rate of 5 percent is assumed for base calculations (EPA, 1988a). The discount rate represents the anticipated difference between the rate of inflation and investment return.

State and Community Acceptance

As discussed in the FS Guidance, EPA will formally evaluate community and State acceptance following review of comments received on the Proposed Plan when publicly available.

The following subsections provide an analysis of each of the remedial alternatives developed for VB/I70 OU1. A summary of the principal components of each alternative is provided, followed by an assessment of the alternative against the threshold and balancing evaluation criteria

6.1 Alternative 1 – No Action

The no action alternative provides a baseline for the evaluation of other alternatives in accordance with the NCP. No additional protective or remediation measures would be taken for the no-action option. As noted previously, soils have been removed from 48 residential properties at the site.

The purpose of including the No Action alternative is to provide a baseline against which the other remedial alternatives can be compared.

6.1.1 Overall Protection of Human Health

The Baseline Human Health Risk Assessment indicates that no further action would be effective in preventing exposures to arsenic in soil above a 1×10^{-4} lifetime cancer risk, a chronic hazard greater than 1, or a sub-chronic hazard quotient greater than 1 for residents who have average or central tendency exposures. However, if no further action is taken at the site, screening level calculations suggest that high rates of soil intake associated with soil pica behavior in children might result in doses of arsenic which exceed an acute hazard quotient of 1, even for the central tendency pica exposure scenario. Also, no further action would not meet the RAOs for arsenic since they are established to be protective of RME exposures.

For lead, in order to help determine whether the IEUBK model is yielding reliable predictions of the risk of elevated blood lead levels in children at the VB/I70 site, USEPA compared the IEUBK model predictions to actual observations of blood lead levels in the population of children currently living at the site. Even though the available data are from studies that were not designed to support risk assessment, they do support the following:

A. Elevated blood lead levels occur in children residing within the site.
B. Soil is not likely to be the main source of elevated blood lead levels.
C. Elevations are not clearly different from areas outside VB/I70.

One alternative IEUBK model run using recently published data on soil ingestion rates for children (Stanek & Calabrese, 2000), the site-specific relative bioavailability and site specific soil/dust ratio adjustments predicts that no further action would be effective in achieving the RAO for lead. The IEUBK model run using default assumptions for all parameters except the site specific relative bioavailability and soil/dust ratio predicts that no further action would not be effective in achieving the

RAO for lead in soil. The range of results from the IEUBK model reflects the uncertainty in predicting whether further action is required to achieve the RAO for lead at the site.

6.1.2 Compliance with ARARs

No activities would occur under the No Action alternative. Therefore, location- and action-specific ARARs would not apply. In addition, there are no applicable chemical-specific ARARs for this alternative.

6.1.3 Short-Term Effectiveness

The No Action Alternative would not entail any actions at the site and therefore would not have any potential impacts on workers, the community or the environment during implementation.

6.1.4 Long-Term Effectiveness and Permanence

No additional controls are required by the No Action alternative, and the magnitude of risk due to potential for direct contact with contaminated soils would not be reduced. The alternative does not meet the requirements of the RAOs and does not provide long-term effectiveness and permanence.

6.1.5 Reduction of Toxicity, Mobility or Volume Through Treatment

The No Action Alternative does not employ any treatment technologies and would therefore not result in any reduction in the mobility, toxicity or volume of metals in the source materials.

6.1.6 Implementability

No actions would be implemented under this alternative.

6.1.7 Cost

The No Action alternative does not have an associated cost. It is used as the baseline comparison of the other alternatives.

6.2 Alternative 2 – Community Health Program, Tilling/Treatment (Lead), Targeted Removal & Disposal (Arsenic)

Alternative 2 contains the following principal components:

- Implementation of a community health program, offered primarily to children at residences where yard soil EPCs exceed 47 mg/Kg arsenic and/or 208 mg/Kg lead, but available to any child that resides in the VB/I70 site.

- In yards with arsenic EPCs greater than 240 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil containing arsenic and lead below PRGs, and pre-remediation yard features restored. Based on RI data, it is estimated that this would occur at a total of 113 residential properties within the site boundaries (including properties not yet sampled).

- In yards with lead EPCs greater than 540 mg/Kg, surface soils would be tilled to a depth of 6 inches and treated with phosphate. Pre-remediation yard features would be restored. Based on RI data, it is estimated that this would occur at a total of 89 residential properties (including properties not yet sampled).

- Upon request from the owner or current resident (if access is granted by the owner), soil will be sampled and tested for lead and arsenic at any residential property within the site boundaries that has not already been adequately tested. If the level of lead exceeds 540 mg/Kg and arsenic is below 240 mg/Kg, soil will be tilled and treated. If the level of arsenic exceeds 240 mg/Kg, soil will be removed and disposed offsite.

6.2.1 Overall Protection of Human Health

Alternative 2 would be expected to meet the requirements of the RAOs and therefore be protective of human health, although there are uncertainties with the effectiveness of the treatment/tilling component.

Removal and offsite disposal of yard soils with arsenic EPCs above 240 mg/Kg would be effective in preventing exposure to these soils and would achieve RAOs A and B for arsenic in soil. The uncertainty analysis performed in the Baseline Human Health Risk Assessment (EPA, 2001a) indicates that actual risks are much more likely to be lower than the calculated point estimates of risks. Providing protection at the 1×10^{-4} risk level based on the point estimates of risk is likely to provide a level of protectiveness for the RME scenario in the range of 2×10^{-5} to 7×10^{-5}.

Tilling/treatment of yard soils with lead EPCs above 540 mg/Kg may be effective in addressing risks associated with these soils and may achieve RAO D for lead in soil. Existing data on effectiveness at other sites are sparse and it is indicated that the required reduction of lead bioavailability is above the range estimated by studies at the Joplin Missouri site. Site-specific treatability testing would be required to determine the chemical form and application rate of the phosphate. In addition, there is uncertainty about the effect of tilling on surface EPCs of lead (detailed lead concentrations with depth data or surface concentrations at different locations are not available for the target properties) and therefore the resultant surface concentrations of lead could not be predicted with accuracy.

For properties where engineering actions were not taken, but which have lead or arsenic EPCs above preliminary action levels, implementation of a community health program would be expected to be effective in managing risks related to lead and arsenic in soil due to the combined components of education, biomonitoring, soil sampling and analysis and response actions as necessary. The community health program is expected to achieve RAO C for arsenic in soil and RAO D for lead in soil when combined with the tilling/treatment component. As discussed in Appendix A, educational interventions have been effective in reducing children's blood-lead concentrations, either alone or in combination with dust control programs. These interventions have also been effective in reducing residential dust-lead loadings. No information was located on the efficacy of education programs intended to reduce pica behavior in children. However, there are many examples of public education programs intended to make people aware of the potential health risks of certain behaviors (smoking, drinking, use of drugs, unprotected sex, etc), including programs aimed at parental monitoring and intervention in behaviors that are hazardous in their children (depression, drug use, etc). Based on these other programs, it is expected that a program aimed at reduction of soil pica behavior would be effective in achieving RAO C for arsenic in soil since the risk is associated with a particular behavior. Biomonitoring and soil sampling and analysis and response actions would add certainty in achieving RAOs C and D. The community health program would also provide an additional public health benefit to the community by reducing soil pica behavior which is likely associated with health risks other than to potential exposure to arsenic. Soil pica behavior is not healthy for children.

6.2.2 Compliance with ARARs

ARARs relating to the generation of fugitive dust and lead concentrations in ambient air would be applicable to actions performed to implement Alternative 2. Although the potential exists for dust generation during soil tilling, excavation, transport and backfilling activities, engineering controls would be readily implementable and effective to achieving compliance with the applicable regulations. ARARs relating to the characterization, transport and disposal of solid wastes would be applicable and would be met by standard construction and transportation practices. Alternative 2 would therefore meet the requirements of all ARARs.

6.2.3 Short-Term Effectiveness

The short-term risk to the community and workers during the implementation of this alternative would be low. Risks would be posed to members of the community due to the operation of heavy equipment in the residential areas (for tilling and removal) and by truck traffic associated with transportation of excavated soil offsite and import of clean backfill.

For soil removal activities, risks would be posed to members of the community by truck traffic associated with transportation of excavated soil offsite and import of clean backfill. As a screening level estimate, a total of approximately 2,200 semi-truck trips would be needed to transport the excavated soil to the disposal facility and to transport the clean backfill soil to the site (about 22,000 cubic yards of excavated soil and 22,000 cubic yards of backfill transported in 20 cubic yard capacity trucks). The injury and fatality rates for accidents involving large trucks in 1997 (most recent data available) were 50.7 per 100 million vehicle miles driven and 2.5 per 100 million vehicle miles driven, respectively. Assuming a transport distance of 15 miles to both the disposal facility and to the backfill source, application of the 1997 statistics estimates that there would be a 3.3 percent probability that one of the trucks would be involved in an accident that injures someone and a 0.16 percent chance of a fatality. It is noted that use of these statistics in this type of screening-level evaluation likely overestimates the actual risks at the VB/I70 site because the probabilities are based on vehicle miles driven, which includes all weather conditions. The risks would be reduced at VB/I70 by following a transportation plan and performing transportation during the summer construction period only.

For the tilling/treatment component, a treatability testing program would be required to evaluate the chemical form and application rates for phosphate and a sampling program would be required to determine the spatial distribution of lead within the surface soils of each yard targeted for remediation. This program would likely take one year to complete and would result in a delay in the implementation of the tilling component of the alternative. There would also be some uncertainty with the effectiveness of this alternative, because the lead concentration depth profiles and the surface lead concentration distribution (presence of hot-spots) at the subject properties are unknown, such that the effect of tilling on surface lead concentrations would not be accurately predictable. In addition, during implementation the soil mixing and treatment chemical application may not be uniform throughout the yard resulting in uncertainty with the overall effectiveness. Therefore, once tilling/treatment had been performed follow-up testing of soils for lead concentrations and treatment effectiveness would need to be performed as well as biomonitoring to evaluate exposures.

Implementation of the community health program would be expected to be effective in managing the risks in other portions of the site related to lead and arsenic in soils due to the combination of components of education, biomonitoring, soil sampling and analysis, and response actions when warranted. As discussed in Appendix A, educational interventions have been effective in reducing children's blood-lead concentrations, either alone or in combination with dust control programs. These interventions have also been effective in reducing residential dust-lead loadings. The addition of biomonitoring, soil sampling and analysis, and response will increase the effectiveness of the community health program at the VB/I70 site. No published studies were located regarding a program to reduce human exposure to arsenic associated with soil pica behavior through a public health type program. However, it is expected that the types of programs that are successful in reducing lead exposure via soil or dust will also be successful in reducing exposure to arsenic in soil at the VB/I70 site, especially if education is tailored to the prevention of soil pica behavior.

6.2.4 Long-Term Effectiveness and Permanence

Alternative 2 would provide a high level of long-term effectiveness and permanence. Soils with lead or arsenic EPCs above risk-based objectives would be addressed by tilling/treatment (lead) or removal (arsenic). A community health program would be expected to be effective in managing any risk from soils at the site through education, biomonitoring, and environmental sampling and response programs. It would provide the additional benefit to the community of providing a mechanism for identifying sources of lead exposure other than soils and abatement of exterior lead paint (under this program if lead paint is a source of contamination to soils and soils at a property are an issue, or by referral to another program otherwise).

6.2.5 Reduction of Toxicity, Mobility or Volume Through Treatment

Alternative 2 contains treatment of soils in conjunction with tilling at 36 properties to reduce the toxicity of lead through stabilization with phosphate. These properties have average lead concentrations in surface soils ranging up to 1,130 mg/Kg. As discussed in Section 4.4.4, data generated by the intensive sampling of 8 properties during the Residential Risk-Based Sampling Investigation were used to evaluate the potential effect of tilling on lead concentrations in surface soils. The investigation generated lead concentrations at 2-inch intervals to a depth of 12 inches. In the evaluation, for each property the lead concentration remaining after tilling was estimated by averaging all concentrations within the tilling depth (i.e., assumed all soil is completely mixed). As shown on Table 4-5, this analysis estimated that for the four properties where surface lead concentrations were above 540 mg/Kg, lead concentrations at the surface would be reduced by between 23% by 6 inch tilling. For the four properties with surface lead concentrations above 540 mg/Kg, these reductions were estimated at 31% for 6 inch tilling. Assuming a 31% reduction at a yard with a current lead concentration at 1,130 mg/Kg, this screening-level evaluation estimates that the resultant surface concentration after tilling would be 790 mg/Kg. In order to reduce the potential exposure to a level equivalent to existing soils with a lead concentration of 195 mg/Kg The PRG), treatment would therefore have to reduce the bioavailability by approximately 75%.

Data are available from recent testing performed at the Joplin, Missouri site (MFG, 2001). At this site lead contaminated soils were amended with phosphoric acid and then limed to bring the pH back to neutral as part of feasibility treatability testing. Since most of the lead in these soils was lead carbonate, the phosphoric acid was quite effective at dissolving the lead and precipitating lead phosphates. There have been three rounds of lead bioavailability testing on the Joplin soils (3, 18, and 30 month post-amendment) in which control (unamended) and amended (0.5 and 1.0% phosphate as phosphorus) soils were dosed to young swine (using the EPA Region VIII swine study protocol). The results suggest a 30-40% reduction in relative lead bioavailability. The control and 18-month post-amendment soil (1% phosphate as phosphorus) were also dosed to adult humans, and stable lead isotope dilution in blood was used to establish lead bioavailability. Preliminary data from this work indicated a 60% reduction in absolute lead bioavailability for the amended soil.

Based on the results of these tests it may be possible to reduce bioavailability of lead in VB/I70 soils more than 75% and therefore meet the requirements of the RAOs, however, there is uncertainty associated with this alternative. Treatability testing would be required to determine the appropriate form and dose of phosphate required for VB/I70.

6.2.6 Implementability

Overall, the implementability of this alternative is expected to be high, with some uncertainties associated with the treatment/tilling component. Soil removal and replacement activities have been performed previously without difficulty at the site and future removal actions would be expected to be readily implementable. Implementation of a community health program is expected to be readily implementable as funding would be available and there are established community organizations, such as neighborhood associations and environmental coalitions that could assist in the distribution of materials. Also, State and local City and County agencies have lead awareness and intervention programs already in place. The addition of arsenic testing and development of educational programs specific to soil pica behavior and arsenic would be easily added since the organizational structure is in place. Tilling of residential soils may be difficult to implement. Areas of accessible soils within yards are relatively small and typically have features such as trees or large shrubs, which would make access and implementation of deep tilling difficult unless removed and replaced. It is likely that due to access constraints tilling would have to be performed using rototillers, which typically have a working depth of about 6 inches. Deeper tilling, if found to be necessary to meet the RAOs, would be difficult to implement.

6.2.7 Cost

The present net worth cost for Alternative 2 is approximately $10.6 million. Detailed information on the unit rates, quantities and assumptions used in the development of the costs are presented in Appendix B.

6.3 Alternative 3 – Community Health Program, Targeted Removal and Disposal

Alternative 3 contains the following principal components:

- Implementation of a community health program offered primarily to children at residences where yard soil EPCs exceed 47 mg/Kg arsenic and/or 208 mg/Kg lead, but available to any child that resides in the VB/I70 site.
- In yards with arsenic EPCs greater than 240 mg/Kg or with lead EPCs above 540 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil containing arsenic and lead below the PRGs, and pre-remediation yard features restored. Based on RI data, it is estimated that this would occur at a total of 202 residential properties (105 properties for arsenic only, 8 for both lead and arsenic and 89 for lead).
- Upon request from the owner or current resident (if access is granted by the owner), soil will be sampled and tested for lead and arsenic at any residential property within the site boundaries that has not already been adequately tested. If the level of lead exceeds 540 mg/Kg or the level of arsenic exceeds 240 mg/Kg, soil will be removed and disposed offsite.

6.3.1 Overall Protection of Human Health

Alternative 3 would meet the requirements of the RAOs and therefore be protective of human health.

Removal and offsite disposal of yard soils with arsenic EPCs above 240 mg/Kg or lead greater than 540 mg/Kg would be effective in preventing exposure to these soils and would achieve RAOs A and B for arsenic in soil and may achieve RAO D for lead in soil. The uncertainty analysis performed in the Baseline Human Health Risk Assessment (EPA, 2001a) indicates that actual arsenic risks are much more likely to be lower than the calculated point estimates of risks. Providing protection at the 1×10^{-4} risk level based on the point estimates of arsenic risk is likely to provide a level of protectiveness for the RME scenario in the range of 2×10^{-5} to 7×10^{-5}.

For properties where engineering actions were not taken, but which have lead or arsenic EPCs above preliminary action levels, implementation of a community health program would be expected to be effective in managing risks associated with lead and arsenic in soil due to the combined components of education, biomonitoring, soil sampling and analysis and response actions as necessary. The community health program is expected to achieve RAO C for arsenic in soil and RAO D for lead in soil when combined with the removal/disposal component. As discussed in Appendix A, educational interventions have been effective in reducing children's blood-lead concentrations, either alone or in combination with dust control programs. These interventions have also been effective in reducing residential dust-lead loadings. No information was located on the efficacy of education programs intended to reduce pica behavior in children. However, there are many examples of public education programs intended to make people aware of the potential health risks of certain behaviors (smoking, drinking, use of drugs, unprotected sex, etc), including programs aimed at parental monitoring and intervention in behaviors that are hazardous in their children (depression, drug use, etc). Based on these other programs, it is expected that a program aimed at reduction of soil pica behavior would be effective in achieving RAO C for arsenic in soil since the risk is associated with a certain behavior. Biomonitoring and soil sampling and analysis and response actions would add certainty in achieving RAOs C and D. The community health program would also provide an additional public health benefit to the community by reducing soil pica behavior which is likely associated with health risks other than to potential exposure to arsenic. Soil pica behavior is not healthy for children.

6.3.2 Compliance with ARARs

ARARs relating to the generation of fugitive dust and lead concentrations in ambient air would be applicable to actions performed to implement Alternative 3. Although the potential exists for dust generation during soil excavation, transport and backfilling activities, engineering controls would be readily implementable and effective to achieving compliance with the applicable regulations. ARARs relating to the characterization, transport and disposal of solid wastes would be applicable and would be met by standard construction and transportation practices. Alternative 3 would therefore meet the requirements of all ARARs.

6.3.3 Short-Term Effectiveness

Low short-term risks would be posed to the community and workers during the implementation of this alternative.

Risks would be posed to members of the community due to the operation of heavy equipment in the residential areas and by truck traffic associated with transportation of excavated soil offsite and import of clean backfill. As a screening level estimate, a total of approximately 3,900 semi-truck trips would be needed to transport the excavated soil to the disposal facility and to transport the clean backfill soil to the site (about 39,000 cubic yards of excavated soil and 39,000 cubic yards of backfill transported in 20 cubic yard capacity trucks). The injury and fatality rates for accidents involving large trucks in 1997 (most recent data available) were 50.7 per 100 million vehicle miles driven and 2.5 per 100 million vehicle miles driven, respectively. Assuming a transport distance of 15 miles to both the disposal facility and to the backfill source, application of the 1997 statistics estimates that there would be a 6.0 percent probability that one of the trucks would be involved in an accident that injures someone and a 0.29 percent chance of a fatality. It is noted that use of these statistics in this type of screening-level evaluation likely overestimates the actual risks at the VB/I70 site because the probabilities are based on vehicle miles driven, which includes all weather conditions. The risks would be reduced at VB/I70 by following a transportation plan and performing transportation during the summer construction period only.

Implementation of the community health program would be expected to be effective in managing the risks in other portions of the site related to lead and arsenic in soils due to the combination of components of education, biomonitoring, soil sampling and analysis, and response actions when warranted. As discussed in Appendix A, educational interventions have been effective in reducing children's blood-lead concentrations, either alone or in combination with dust control programs. These interventions have also been effective in reducing residential dust-lead loadings. The addition of biomonitoring, soil sampling and analysis, and response will increase the effectiveness of the community health program at the VB/I70 site. No published studies were located regarding a program to reduce human exposure to arsenic associated with soil pica behavior through a public health type program. However, it is expected that the types of programs that are successful in reducing lead exposure via soil or dust will also be successful in reducing exposure to arsenic in soil at the VB/I70 site, especially if education is tailored to the prevention of soil pica behavior.

6.3.4 Long-Term Effectiveness and Permanence

Alternative 3 would provide a high level of long-term effectiveness and permanence. Soils with lead or arsenic EPCs above risk-based objectives would be removed from the site. A community health program would be expected to be effective in managing any risk from soils at the site through education, biomonitoring, and environmental sampling and response programs. It would provide the additional benefit to the community of providing a mechanism for identifying sources of lead exposure other than soils and abatement (abatement of exterior lead-paint would be performed under this program if soils at a property are an issue, or by referral to another program if soils are not an issue).

6.3.5 Reduction of Toxicity, Mobility or Volume Through Treatment

Alternative 3 does not include a treatment component to reduce toxicity, mobility or volume of contaminated soil.

6.3.6 Implementability

The removal/disposal component of Alternative 3 would be implementable with standard equipment and services, and adequate personnel would be readily available for this type of work. The construction technologies required to implement this alternative are commonly used and widely accepted. Numerous similar projects of comparable and larger scale have been implemented across the United States and in Denver. Removal is a reliable technology and no future remedial actions would be required because soils of concern would be removed from the site.

The community health program would also be readily implementable. From a technical perspective these types of programs are commonly implemented, both at Superfund sites and for other issues such as risks associated with lead paint in residential areas. The program would include monitoring to assess the on-going effectiveness of the remedy and would include the implementation of soil removals where necessary to mitigate risk. The program would also be readily implementable from an administrative perspective as funding would be available and there are established community organizations, such as neighborhood associations and environmental coalitions that could assist in the distribution of materials. Also, State and local City and County agencies have lead awareness and intervention programs already in place. The addition of arsenic testing and development of educational programs specific to soil pica behavior and arsenic would be easily added since the organizational structure is in place.

6.3.7 Cost

The present net worth cost for Alternative 3 is approximately $11.1 million. Detailed information on the unit rates, quantities and assumptions used in the development of the costs are presented in Appendix B.

6.4 Alternative 4 – Community Health Program, Expanded Removal and Disposal

Alternative 4 contains the following principal components:

- Implementation of a community health program offered primarily to children at residences where yard soil EPCs exceed 47 mg/Kg arsenic and/or 208 mg/Kg lead, but available to any child that resides in the VB/I70 site.

- In yards with arsenic EPCs greater than 128 mg/Kg or with lead EPCs above 540 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil containing arsenic and lead below PRGs, and pre-remediation yard features restored. Based on RI data, it is estimated that this would occur at a total of 403 residential properties (306 properties for arsenic only, 31 for both lead and arsenic and 66 for lead).

- Upon request from the owner or current resident (if access is granted by the owner), soil will be sampled and tested for lead and arsenic at any residential property within the site boundaries that has not already been adequately tested. If the level of lead exceeds 540 mg/Kg or the level of arsenic exceeds 128 mg/Kg, soil will be removed and disposed offsite.

6.4.1 Overall Protection of Human Health

Alternative 4 would meet the requirements of the RAOs and therefore be protective of human health.

Removal and offsite disposal of yard soils with arsenic EPCs above 128 mg/Kg or lead greater than 540 mg/Kg would be effective in preventing exposure to these soils and would achieve RAOs A and B for arsenic in soil and may achieve RAO D for lead in soil. For properties where engineering actions were not taken, but which have lead or arsenic EPCs above preliminary action levels, implementation of a community health program would be expected to be effective in managing risks related to lead and arsenic in soil due to the components of education, biomonitoring, soil sampling and analysis and response actions when warranted. The community health program would be expected to achieve RAO C for arsenic in soil and RAO D for lead in soil when combined with the removal/disposal component. As discussed in Appendix A, educational interventions have been effective in reducing children's blood-lead concentrations, either alone or in combination with dust control programs. These interventions have also been effective in reducing residential dust-lead loadings. No information was located on the efficacy of education programs intended to reduce pica behavior in children. However, there are many examples of public education programs intended to make people aware of the potential health risks of certain behaviors (smoking, drinking, use of drugs, unprotected sex, etc), including programs aimed at parental monitoring and intervention in behaviors that are hazardous in their children (depression, drug use, etc). Based on these other programs, it is expected that a program aimed at reduction of soil pica behavior would be effective in achieving RAO C for arsenic in soil since the risk is associated with a particular behavior. Biomonitoring and soil sampling and analysis and response actions would add certainty in achieving RAOs C and D. The community health program would also provide an additional public health benefit to the community by reducing soil pica behavior which is likely associated with health risks other than to potential exposure to arsenic. Soil pica behavior is not healthy for children.

6.4.2 Compliance with ARARs

ARARs relating to the generation of fugitive dust and lead concentrations in ambient air would be applicable to actions performed to implement Alternative 4. Although the potential exists for dust generation during soil excavation, transport and backfilling activities, engineering controls would be readily implementable and effective to achieving compliance with the applicable regulations. ARARs relating to the characterization, transport and disposal of solid wastes would be applicable and would be met by standard construction and transportation practices. Alternative 4 would therefore meet the requirements of all ARARs.

6.4.3 Short-Term Effectiveness

Low short-term risks would be posed to the community and workers during the implementation of this alternative.

Risks would be posed to members of the community due to the operation of heavy equipment in the residential areas and by truck traffic associated with transportation of excavated soil offsite and import of clean backfill. As a screening level estimate, a total of approximately 8,000 semi-truck trips would be needed to transport the excavated soil to the disposal facility and to transport the clean backfill soil to the site (about 80,000 cubic yards of excavated soil and 80,000 cubic yards of backfill transported in 20 cubic yard capacity trucks). The injury and fatality rates for accidents involving large trucks in 1997 (most recent data available) were 50.7 per 100 million vehicle miles driven and 2.5 per 100 million vehicle miles driven, respectively. Assuming a transport distance of 15 miles to both the disposal facility and to the backfill source, application of the 1997 statistics estimates that there would be a 12 percent probability that one of the trucks would be involved in an accident that injures someone and a 0.6 percent chance of a fatality. It is noted that use of these statistics in this type of screening-level evaluation likely overestimates the actual risks at the VB/I70 site because the probabilities are based on vehicle miles driven, which includes all weather conditions. The risks would be reduced at VB/I70 by following a transportation plan and performing transportation during the summer construction period only.

Implementation of the community health program would be expected to be effective in managing the risks in other portions of the site related to lead and arsenic in soils due to the combination of components of education, biomonitoring, soil sampling and analysis, and response actions when warranted. As discussed in Appendix A, educational interventions have been effective in reducing children's blood-lead concentrations, either alone or in combination with dust control programs. These interventions have also been effective in reducing residential dust-lead loadings. The addition of biomonitoring, soil sampling and analysis, and response will increase the effectiveness of the community health program at the VB/I70 site. No published studies were located regarding a program to reduce human exposure to arsenic associated with soil pica behavior through a public health type program. However, it is expected that the types of programs that are successful in reducing lead exposure via soil or dust will also be successful in reducing exposure to arsenic in soil at the VB/I70 site, especially if education is tailored to the prevention of soil pica behavior.

6.4.4 Long-Term Effectiveness and Permanence

Alternative 4 would provide a high level of long-term effectiveness and permanence. Soils with lead or arsenic EPCs above risk-based objectives would be removed from the site. A community health program would be expected to be effective in managing any risk from soils at the site through education, biomonitoring, and environmental sampling and response programs. It would provide the additional benefit to the community of providing a mechanism for identifying sources of lead exposure other than soils and abatement (abatement of exterior lead-paint would be performed under this program if soils at a property are an issue, or by referral to another program if soils are not an issue).

6.4.5 Reduction of Toxicity, Mobility or Volume Through Treatment

Alternative 4 does not include a treatment component to reduce toxicity, mobility or volume of contaminated soil.

6.4.6 Implementability

The removal/disposal component of Alternative 4 would be implementable with standard equipment and services, and adequate personnel would be readily available for this type of work. The construction technologies required to implement this alternative are commonly used and widely accepted. Numerous similar projects of comparable and larger scale have been implemented across the United States and in Denver. Removal is a reliable technology and no future remedial actions would be required because soils of concern would be removed from the site.

The community health program would also be readily implementable. From a technical perspective these types of programs are commonly implemented, both at Superfund sites and for other issues such as risks associated with lead paint in residential areas. The program would include monitoring to assess the on-going effectiveness of the remedy and would include the implementation of soil removals where necessary to mitigate risk. The program would also be readily implementable from an administrative perspective as funding would be available and there are established community organizations, such as neighborhood associations and environmental coalitions that could assist in the distribution of materials. Also, State and local City and County agencies have lead awareness and intervention programs already in place. The addition of arsenic testing and development of educational programs specific to soil pica behavior and arsenic would be easily added since the organizational structure is in place.

6.4.7 Cost

The present net worth cost for Alternative 4 is approximately $17.5 million. Detailed information on the unit rates, quantities and assumptions used in the development of the costs are presented in Appendix B.

6.5 Alternative 5 – Removal & Disposal

Alternative 5 contains the following principal components:

- In yards with arsenic EPCs greater than 47 mg/Kg or with lead EPCs above 208 mg/Kg accessible soils would be removed to a depth of 12 inches and transported offsite for disposal at an appropriate facility. The excavation areas would be backfilled with clean soil with lead and arsenic concentrations below PRGs, and pre-remediation yard features restored.

Under this alternative, properties that were not sampled during the RI would be systematically sampled and soil removed from yards where lead or arsenic EPCs exceeded the action levels. It is estimated that this would be required at 2,122 properties.

6.5.1 Overall Protection of Human Health

Alternative 5 would meet the requirements of the RAOs by removal of all soil with lead or arsenic EPCs above levels of concern from the site. It would provide a moderate to high level of protection of human health due to the short-term risks associated with transportation of excavated soil from the site and of clean backfill to the site.

In addition, it is noted that other sources of lead exposure are likely present at the site, which would not be evaluated under this alternative. The USEPA sponsored a study in urban areas of Baltimore, Boston and Cincinnati to investigate the efficacy of soil and dust abatement techniques in reducing blood lead values in children (USEPA, 1995). Because of the study design, this investigation is usually referred to as the "three cities study". Among the key findings of this study was the conclusion that:

"... soil abatement alone will have little or no effect on reducing exposure to lead unless there is a substantial amount of lead in soil and unless this lead is the primary source of lead in house dust"

The report did not rigorously define "substantial", but it was only when soil lead levels were higher than 1,000 to 2,000 mg/Kg that a benefit from soil remediation was detectible. Conversely, in two cities where soil lead levels were mainly less than 1,000 mg/Kg, no substantial decrease in blood leads could be detected following soil remediation. As noted earlier, 99% of all properties tested in Phase III at the VB/I70 site have soil lead concentrations below 700 mg/Kg, with only three properties being above 1,000 mg/Kg. Also recall that, at the VB/I70 site, available data indicate that only about 34% of the mass of interior dust appears to be derived from yard soil. Thus, it appears that neither of the two conditions needed for soil removal to be effective are likely to apply at most properties at the VB/I70 site. This alternative does not have a community health program component and therefore would not have any effect on the occurrence of soil pica behavior in the community; a behavior that may result in risks to children separate from exposure to arsenic in soil.

6.5.2 Compliance with ARARs

ARARs relating to the generation of fugitive dust and lead concentrations in ambient air would be applicable to actions performed to implement Alternative 5. Although the potential exists for dust generation during soil excavation, transport and backfilling activities, engineering controls would be readily implementable and effective to achieving compliance with the applicable regulations. ARARs relating to the characterization, transport and disposal of solid wastes would be applicable and would be met by standard construction and transportation practices. Alternative 5 would therefore meet the requirements of all ARARs.

6.5.3 Short-Term Effectiveness

The short-term risk to the community and workers during implementation of this alternative would be moderate.

Risks would be posed to members of the community due to the operation of heavy equipment in the residential areas and by truck traffic associated with transportation of excavated soil offsite and import of clean backfill. As a screening level estimate, a total of approximately 43,000 semi-truck trips would be needed to transport the excavated soil to the disposal facility and to transport the clean backfill soil to the site (about 430,000 cubic yards of excavated soil and an equal amount of backfill transported in 20 cubic yard capacity trucks). The injury and fatality rates for accidents involving large trucks in 1997 (most recent data available) were 50.7 per 100 million vehicle miles driven and 2.5 per 100 million vehicle miles driven, respectively. Assuming a transport distance of 15 miles to both the disposal facility and to the backfill source, application of the 1997 statistics estimates that there would be a 65 percent probability that one of the trucks would be involved in an accident that injures someone and a 3.2 percent chance of a fatality. It is noted that use of these statistics in this type of screening-level evaluation likely overestimates the actual risks at the VB/I70 site because the probabilities are based on vehicle miles driven, which includes all weather conditions. The risks would be reduced at VB/I70 by following a transportation plan and performing transportation during the summer construction period only.

6.5.4 Long-Term Effectiveness and Permanence

This alternative would provide a high degree of long-term effectiveness and protection, because all soils with lead or arsenic EPCs above levels of concern would be removed from the site. However, this alternative would do nothing to reduce the incidence of soil pica behavior nor reduce the uncertainties in our ability to estimate risks associated with this behavior. It is possible that acute exposures to arsenic associated with soil pica behavior could occur at arsenic EPCs below 47 mg/Kg.

6.5.5 Reduction of Toxicity, Mobility or Volume Through Treatment

Alternative 5 does not include a treatment component to reduce toxicity, mobility or volume of contaminated soil. Contaminated soils are addressed by removal from the site.

6.5.6 Implementability

Alternative 5 would be implementable with standard equipment and services, and adequate personnel would be readily available for this type of work. The construction technologies required to implement this alternative are commonly used and widely accepted. Due to the relatively large volumes of soil to be excavated and disposed and clean replacement backfill, relatively large disposal facilities and backfill borrow sources would be required. However, similar projects of this scale have been implemented across the United States, including a relatively large residential soil removal program implemented in areas adjacent to the VB/I70 site. The removals would likely take about 5 years to complete. Removal is a reliable technology and no future remedial actions would be required because soils of concern would be removed from the site.

6.5.7 Cost

The present net worth cost for Alternative 5 is approximately $61.0 million. Of this amount, approximately $15.6 million of the costs are associated with remediation of properties with arsenic EPCs greater than 47 mg/Kg, but less than 128 mg/Kg. Detailed information on the unit rates, quantities and assumptions used in the development of the costs are presented in Appendix B.

7.0 COMPARATIVE ANALYSIS

This section presents a comparative analysis of the remedial alternatives developed for the residential soils of VB/I70 OU1. The purpose of this analysis is to compare the advantages and disadvantages of each remedial alternative brought forth in the detailed analysis against the threshold and balancing criteria presented in Section 6.0. The comparison focuses on the significant areas of difference, especially identification of any alternative that is clearly superior in meeting a criterion.

The No Action Alternative is not evaluated in the comparative analysis, but is considered as the baseline condition. The Baseline Human Health Risk Assessment indicates that no further action would be effective in preventing exposures to arsenic in soil above a $1x10^{-4}$ lifetime cancer risk, a chronic hazard greater than 1, or a sub-chronic hazard quotient greater than 1 for residents who have average or central tendency exposures. However, if no further action is taken at the site, screening level calculations suggest that high rates of soil intake associated with soil pica behavior in children might result in doses of arsenic which exceed an acute hazard quotient of 1, even for the central tendency pica exposure scenario. Also, no further action would not meet the RAOs for arsenic since they are established to be protective of RME exposures.

For lead, in order to help determine whether the IEUBK model is yielding reliable predictions at the VB/I70 site, USEPA compared the IEUBK model predictions to actual observations of blood lead levels in the population of children currently living at the site. Even though the available data are from studies that were not designed to support risk assessment, they do support the following:

A. Elevated blood lead levels occur in children residing within the site.
B. Soil is not likely to be the main source of elevated blood lead levels.
C. Elevations are not clearly different from areas outside VB/I70.

One alternative IEUBK model run using recently published data on soil ingestion rates for children (Stanek & Calabrese, 2000), the site-specific relative bioavailability and site specific soil/dust ratio adjustments predicts that no further action would be effective in achieving the RAO for lead. The

IEUBK model run using default assumptions for all parameters except the site specific relative bioavailability and soil/dust ratio predicts that no further action would not be effective in achieving the RAO for lead in soil. The range of results reflects the uncertainty in predicting whether further action is required to achieve the RAO for lead at the site.

The first stage of the analysis, presented in Section 7.1, summarizes and comparatively analyzes each alternative's achievement of the threshold criteria of overall protectiveness and compliance with ARARs, as required by the NCP. The second stage of analysis involves a discussion of the relative advantages and disadvantages of the alternatives with respect to the five primary balancing criteria under the NCP, and is discussed in Section 7.2. A summary of the comparative analysis is presented in Table 7-1.

7.1 Threshold Criteria Analysis

This section presents the comparative analysis of the three action alternatives against the threshold criteria of overall protection of human health and compliance with ARARs.

7.1.1 Overall Protection of Human Health

There is not a large difference is the performance of each of the alternatives against this criterion. Overall, however, the highest level of protection of human health as measured by the requirements of the RAOs would be achieved by Alternative 3. Removal and offsite disposal of yard soils with arsenic EPCs above 240 mg/Kg or lead EPCs greater than 540 mg/Kg would be effective in preventing exposure to these soils, which are of the greatest concern with respect to human health risk. For other properties, implementation of a community health program would be expected to be effective in managing the remaining risks from soils due to the components of education, biomonitoring, source sampling and analysis, and response actions as necessary. In addition, the community health program would provide additional protection for the community, because it would provide the mechanism for evaluating other sources of lead (such as lead paint) that may cause exposures in the future, and for evaluating soil pica behavior which may be associated with other risks in addition to the risk of acute arsenic exposure.

Alternative 2 may provide a similar level of protection compared to Alternative 3, but there is some uncertainty associated with the tilling/treatment component to address soils with lead EPCs above 540 mg/Kg. Uncertainties are associated with the effect of tilling on surface soil concentrations (concentration profiles were not generated with depth or in different yard locations for the target properties, and therefore the resultant lead concentrations in surface soil after tilling are difficult to predict). Also, the effectiveness of phosphate treatment is uncertain (site-specific testing would be required to determine the chemical form and application rate; this would lead to a delay of at least a year in implementing this portion of the remedy).

Alternative 4 differs from Alternative 3 by adding soil removal from properties with arsenic concentrations greater than 128 mg/Kg. This alternative was developed and evaluated based on CDPHE comments regarding cleanup goals at the adjacent Globeville site (see Appendix D). Based on the findings of the Baseline Human Health Risk Assessment, this arsenic EPC corresponds to a point estimate risk level of 8×10^{-5}. Therefore the additional removal would address risks within EPA's acceptable risk range and would provide this level of protection for the 99th percentile of the exposed population, exposures which are very likely not occurring at the site. The RAO to prevent additional lifetime cancer risk due to ingestion of arsenic in soil and homegrown vegetables was established based on the findings of the risk assessment, consistent with the guidance set out in the OSWER Directive 9355.0-30 "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions". In part, this guidance states that "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less that 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, action is not warranted unless there are adverse environmental impacts." The directive further states that consideration of uncertainties in the baseline risk assessment may lead a risk manager to decide that risks lower than 10^{-4} are unacceptable, triggering the need for remedial action. EPA considered the uncertainty in the arsenic risk calculations for VB/I70 to determine whether remedial action is needed at properties where risks are predicted to be less than or equal to 10^{-4}. The uncertainty analysis in the Baseline Human Health Risk Assessment indicates that actual risks are much more likely to be lower than the calculated point estimates of risks. Providing protection at the 1 x 10^{-4} risk level based on the point estimates of risk is likely to provide a level of protectiveness for the RME scenario in the range of 2 x 10^{-5} to 7 x 10^{-5}. Therefore, it is not necessary to perform soil removals where arsenic EPCs exceed 128 mg/Kg in order to achieve protectiveness in this range for the RME scenario.

Alternative 5 would provide the highest level of long-term protection and permanence against risks associated with soils because soils with arsenic and lead at levels of concern would be removed from the site. However, the extensive removals would entail short-term risks to the community due to the presence and operation of heavy equipment and the large number of truck trips required to dispose excavated soil offsite and to transport clean fill to the site. In addition, from a community perspective Alternative 5 may not provide the highest overall protection since it is likely that other sources of lead exist that would not be identified under this alternative and the occurrence of soil pica behavior would not be affected. The USEPA sponsored a study in urban areas of Baltimore, Boston and Cincinnati to investigate the efficacy of soil and dust abatement techniques in reducing blood lead values in children (USEPA 1995). Because of the study design, this investigation is usually referred to as the "three cities study". Among the key findings of this study was the conclusion that:

"... soil abatement alone will have little or no effect on reducing exposure to lead unless there is a substantial amount of lead in soil and unless this lead is the primary source of lead in house dust"

The report did not rigorously define "substantial", but it was only when soil lead levels were higher than 1,000 to 2,000 mg/Kg that a benefit from soil remediation was detectible. Conversely, in two cities where soil lead levels were mainly less than 1,000 mg/Kg, no substantial decrease in blood leads could be detected following soil remediation. As noted earlier, 99% of all properties tested in Phase III at the VB/I70 site have soil lead concentrations below 700 mg/Kg, with only three properties being above 1,000 mg/Kg. Also recall that, at the VB/I70 site, available data indicate that only about 34% of the mass of interior dust appears to be derived from yard soil. Thus, it appears that neither of the two conditions needed for soil removal to be effective are likely to apply at most properties at the VB/I70 site.

7.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

All of the remedial alternatives evaluated in the comparative analysis would be expected to comply with ARARs. ARARs relating to the generation of fugitive dust and lead concentrations in ambient air would be applicable to the range of engineering actions under evaluation. Although the potential exists for dust generation during soil tilling and excavation, and transport and backfilling activities, engineering controls would be readily implementable and effective to achieving compliance with the applicable regulations. ARARs relating to the characterization, transport and disposal of solid wastes would be applicable for excavated soils and would be met by standard construction and transportation practices.

7.2 Primary Balancing Criteria Analysis

This section presents the comparative analysis of the three action alternatives for the primary balancing criteria of short-term effectiveness, long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, implementability, and cost.

7.2.1 Short-Term Effectiveness

Alternative 3 provides the highest level of short-term effectiveness. Soil removal actions could be quickly and effectively implemented with little risk to workers or the community. Implementation of the community health program would be expected to be effective in managing the risks in other portions of the site related to lead and arsenic in soil due to the components of education, biomonitoring, soil sampling and analysis, and response actions when warranted.

Alternative 2 provides a slightly lower level of short-term effectiveness than Alternative 3, primarily because tilling/treatment actions would be delayed while treatability testing was performed and because there would be some uncertainties with the immediate effectiveness of the tilling/treatment activities due to lack of data on lead concentrations with depth and at different locations in the targeted yards.

Alternative 4 provides a slightly lower level of short-term effectives than Alternative 3, primarily because additional removals at properties with arsenic EPCs greater than 128 mg/Kg would entail greater risks due to the larger scope of removal actions and transportation of excavated soil and clean backfill through neighborhood streets, while not contributing to additional long-term protection of human health as set out by the requirements of the RAOs.

Alternative 5 would provide the lowest level of short-term effectiveness because of increased risks to workers and the community due to the long-term operation of heavy equipment in the residential areas and by truck traffic associated with transportation of excavated soil offsite and import of clean backfill (approximately 43,000 truck trips would be required).

7.2.2 Long-Term Effectiveness and Permanence

Alternative 5 would provide the highest level of long-term effectiveness and permanence against risks associated with soils, because all soil with lead or arsenic EPCs above levels of concern would be removed from the site. However, from a community perspective it may not provide the highest overall protection since it is likely that there are other sources of lead (such as lead-based paint), which would not be evaluated and the occurrence of soil pica behavior would not be affected. Alternatives 2, 3 and 4 would provide a high level of long-term effectiveness by addressing soils with lead or arsenic EPCs at levels above risk-based objectives by tilling and treatment and/or removal. Risks associated with remaining yard soils would be effectively managed by implementation of a community health program under these alternatives. The program would provide the additional benefit to the community of providing a mechanism for identifying sources of lead exposure other than soils and abatement (abatement of exterior lead-paint would be performed under this program if soils at a property are an issue, or by referral to another program if soils are not an issue), and a program to reduce the likelihood of soil pica behavior within VB/I70.

7.2.3 Reduction of Toxicity, Mobility or Volume Through Treatment

Alternatives 3, 4 and 5 do not contain a treatment component and therefore Alternative 2 would result in the highest reduction of toxicity and mobility due to treatment. However, there are uncertainties with the treatment process and site-specific testing would have to be performed to evaluate the chemical form and application rate of phosphate and to evaluate the overall treatment effectiveness once implemented.

7.2.4 Implementability

Alternatives 3, 4 and 5 would be readily implementable with standard equipment and services, and adequate personnel would be readily available for this type of work. The construction technologies required to implement these alternatives are commonly used and widely accepted. For Alternative 2, tilling of residential soils may be difficult to implement. Areas of accessible soils within yards are relatively small and typically have features such as trees or large shrubs, which would make access and implementation of deep tilling difficult unless the features were removed and replaced. It is likely that due to access constraints tilling would have to be performed using rototillers, which typically have a working depth of about 6 inches. Lead concentrations with depth have not been generated for the target properties and if deeper tilling is found to be necessary to meet the RAOs it would be difficult to implement.

7.2.5 Cost

Estimated costs for each alternative considered in the comparative analysis are shown below. These costs include direct and indirect capital costs and review costs for 30 years (there are no operation and maintenance costs associated with any of the alternatives).

Remedial Alternative	Net Present Worth Cost (Millions)
Alternative 2	10.6
Alternative 3	11.1
Alternative 4	17.5
Alternative 5	61.0 (1)

Note: (1) Of this amount, approximately $15.6 million is associated with remediation of properties with arsenic EPCs above 47 mg/Kg but below 128 mg/Kg.

All action alternatives meet the threshold requirements of protection of human health and compliance with ARARs. Alternative 3 provides a greater level of overall certainty for protecting human health compared to Alternative 2 and entails lower costs than Alternatives 4 and 5.

8.0 REFERENCES

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TABLES

TABLE 3-1

SUMMARY OF POTENTIAL CHEMCIAL-SPECIFIC ARARs
VB/I-70 OU1

Standard, Requirement or Criteria	Potentially Applicable	Potentially Relevant and Appropriate	Citation	Description	Comment
FEDERAL					
National Ambient Air Quality Standards	No	Yes	40 CFR Part 50	Establishes ambient air quality standards for certain "criteria pollutants" to protect public health and welfare. Standard is: 1.5 micrograms lead per cubic meter maximum - arithmetic mean averaged over a calendar quarter	National ambient air quality standards (NAAQS) are implemented through the New Source Review Program and State Implementation Plans (SIPs). The federal New Source Review Program addresses only major sources. Emissions associated with proposed remedial action at VB/I70 OU1 would be limited to fugitive dust emissions associated with earth moving activities during construction. These activities will not constitute a major source. Therefore, attainment and maintenance of NAAQS pursuant to the New Source Review Program are not applicable. However, the standards relating to lead are relevant and appropriate.
STATE					
Colorado Air Pollution Prevention and Control Act	Yes	--	5 CCR 1001-14;	Applicants for construction permits are required to evaluate whether the proposed source will exceed NAAQS.	Construction activities associated with potential remedial actions at the site would be limited to generation of fugitive dust emissions. Colorado regulates fugitive emissions through Regulation No. 1. Compliance with applicable provisions of the Colorado air quality requirements would be achieved by adhering to a fugitive emissions dust control plan prepared in accordance with Regulation No. 1. This plan will discuss monitoring requirements, if any, necessary to achieve these standards.
	No	Yes	5 CCR 1001-10 Part C (I) Regulation 8	Regulation No. 8 sets emission limits for lead from stationary sources at 1.5 micrograms per standard cubic meter averaged over a one-month period.	Regulation is for stationary sources and is therefore not applicable. However, it is relevant and appropriate. Applicants are required to evaluate whether the proposed activities would result in an exceedance of this standard. The potential remedial actions at the site are not expected to exceed the emission levels for lead, although some lead emissions may occur. Compliance with the requirements of Regulation No. 8 would be achieved by adhering to a fugitive emissions dust control plan prepared in accordance with Regulation No. 1. This plan will discuss monitoring requirements, if any, necessary to achieve these standards.

TABLE 3-2

SUMMARY OF POTENTIAL LOCATION-SPECIFIC ARARs

Standard, Requirement or Criteria	Potentially Applicable	Potentially Relevant and Appropriate	Citation	Description	Comment
SUMMARY OF POTENTIAL LOCATION-SPECIFIC ARARs					
Resource Conservation and Recovery Act (RCRA), Subtitle D	No	No	40 CFR 257	Facilities where treatment, storage, or disposal of solid waste will be conducted must meet certain location standards. These include location restrictions on proximity of airports, floodplains, wetlands, fault areas, seismic impact zones, and unstable areas.	Applicable only if interim disposal is conducted or if an onsite repository is necessary. However, because onsite disposal is not a component of any alternative under consideration, this regulation is not an ARAR.
Executive Order No. 11990 Protection of Wetlands	No	No	40 CFR § 6.302(a) and Appendix A	Minimizes adverse impacts on areas designated as wetlands.	Not ARARs as remedial actions will occur on individual yards where there are no wetlands. Also onsite disposal is not a component of any alternative under consideration.
Executive Order No. 11988 Floodplain Management	No	No	40 CFR § 6.302 & Appendix A	Pertains to floodplain management and construction of impoundments in such areas.	Not ARARs because the remedial actions do not require the occupation or modification of flood plains.
Section 404, Clean Water Act (CWA)	No	No	33 USC 1251 et seq. 33 CFR Part 330	Regulates discharge of dredged or fill materials into waters of the United States.	The Act is not an ARAR. Onsite disposal which affects waters of the US is not a component of any alternative under consideration.
Endangered Species Act	Yes	No	16 USC § 1531 et seq.; 50 CFR 200 and 402	Provides protection for threatened and endangered species and their habitats.	Due to the urban nature of the site, threatened or endangered species are highly unlikely to be present. However, the Act would be applicable if endangered species were identified and affected by the selected remedial alternative.
Wilderness Act	No	No	16 USC 1311; 16 USC 668; 50 CFR 53; 50 CFR 27	Limits activities within areas designated as wilderness areas or National Wildlife Refuge Systems.	These types of areas are not present at the site and therefore the Act is not an ARAR.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS

STATE ARARS					
Action	**Potentially Applicable**	**Potentially Relevant and Appropriate**	**Citation**	**Description**	**Comments**
Hazardous and Solid Waste: 1. Solid waste determination	Yes	--	6 CCR 1007-3 Part 260 6 CCR 1007-3 Sect. 260.30-31 6 CCR 1007-3 Sect. 261.2 6 CCR 1007-3 Sect. 261.4	A solid waste is any discarded material that is not excluded by a variance granted under 40 CFR 260.30 and 260.31. Discarded material includes abandoned, recycled, and waste-like materials.	Applicable to alternatives where contaminated soil is excavated and disposed.
2. Solid waste classification.	Yes	--	6 CCR 1007-2, Section 1	If a generator of wastes has determined that the wastes do not meet the criteria for hazardous wastes, they are classified as solid wastes.	Applicable to alternatives where contaminated soil is excavated and disposed.
3. Determination of hazardous waste.	Yes	--	6 CCR 1007-3 Sect. 262.11 6 CCR 1007-3 Part 261	Wastes generated during soil excavation activities must be characterized and evaluated according to the following method to determine whether the waste is hazardous. Excavated soil would be classified as D004 hazardous waste if the arsenic concentration from the TCLP test was greater than 5.0 milligrams per liter. Excavated soil would be classified as D008 hazardous waste if the lead concentration from the TCLP test was greater than 5.0 milligrams per liter.	Applicable to alternatives where contaminated soil is excavated and disposed.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS (continued)

STATE ARARS					
Action	**Potentially Applicable**	**Potentially Relevant and Appropriate**	**Citation**	**Description**	**Comments**
Air Emission Control 4. Particulate emissions during excavation and backfill.	Yes	--	5 CCR 1001-3, Regulation 1, Section III (D) 5 CCR 1001-5, Regulation 3 5 CCR 1001-2, Section II	Colorado air pollution regulations require owners or operators of sources that emit fugitive particulates to minimize emissions through use of all available practical methods to reduce, prevent, and control emissions. In addition, no off-site transport of particulate matter is allowed. A fugitive dust control measure will be written into the workplan in consultation with the state for the remedial activity.	Applicable to alternatives where soil is excavated, moved, stored, transported or redistributed.
5. Emission of hazardous air pollutants.	No	Yes	5 CCR 1001-10, Regulation 8	Emission of certain hazardous air pollutants is controlled by NESHAPs. Excavation and backfill of soils could potentially cause emission of hazardous air pollutants. Regulation No. 8 sets emission limits for lead from stationary sources at 1.5 micrograms per standard cubic meter averaged over a one-month period.	Regulation is for stationary sources and is therefore not applicable. However, it is relevant and appropriate. Applicants are required to evaluate whether the proposed activities would result in an exceedance of this standard. The potential remedial actions at the site are not expected to exceed the emission levels for lead, although some lead emissions may occur. Compliance with the requirements of Regulation No. 8 would be achieved by adhering to a fugitive emissions dust control plan prepared in accordance with Regulation No. 1. This plan will discuss monitoring requirements, if any, necessary to achieve these standards.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS (continued)

STATE ARARS					
Action	**Potentially Applicable**	**Potentially Relevant and Appropriate**	**Citation**	**Description**	**Comments**
6. Air emissions from diesel-powered vehicles associated with excavation and backfill operations.	Yes	--	5 CCR 1001-15, Regulation 12	Colorado Diesel-Powered Vehicle Emissions Standards for Visible Pollutants apply to motor vehicles intended, designed, and manufactured primarily for use in carrying passengers or cargo on roads, streets, and highways, and state as follows: 1) No person shall emit or cause to be emitted into the atmosphere from any diesel-powered motor vehicle weighting 7,500 pounds and less, empty weight, any air contaminant, for a period greater than five (5) consecutive seconds, which is of such a shade or density as to obscure an observer's vision to a degree in excess of 40% opacity. 2) No person shall emit or cause to be emitted into the atmosphere from any diesel-powered motor vehicle weighing more than 7,500 pounds, empty weight, any air contaminant, for a period greater than five (5) consecutive seconds, which is of such a shade or density as to obscure an observer's vision to a degree in excess of 35% opacity, with the exception of subpart "C". 3) Any diesel-powered motor vehicle exceeding these requirements shall be exempt for a period of 10 minutes if the emissions are a direct result of a cold engine startup and provided the vehicle is in a stationary position. 4) These standards shall apply to motor vehicles intended, designed, and manufactured primarily for travel or use in transporting persons, property, auxiliary equipment, and/or cargo over roads, streets, and highways.	Applicable to alternatives that include transportation of soil.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS (continued)

STATE ARARS					
Action	**Potentially Applicable**	**Potentially Relevant and Appropriate**	**Citation**	**Description**	**Comments**
7. Odor emissions.	Yes	--	5 CCR 1001-4, Regulation 2	Colorado odor emission regulations require that no person shall allow emission of odorous air contaminants that result in detectable odors that are measured in excess of the following limits: For residential and commercial areas -- odors detected after the odorous air has been diluted with seven more volumes of odor-free air.	Applicable to alternatives that include construction activities in residential areas.
8. Smoke and opacity.	No	Yes	5 CCR 1001-3, Regulation 1, Sect. II.A	Excavation and backfilling of soils must be conducted in a manner that will not allow or cause the emission into the atmosphere of any air pollutant that is in excess of 20% opacity.	Regulation specifically exempts fugitive emissions generated by excavation/backfilling activities. Relevant and appropriate to alternatives that include excavation and backfilling of soils.
9. Ambient Air Standard for Total Suspended Particulate Matter.	Yes	--	5 CCR 1001-14	Air quality standards for particulates (as PM10) are 50 $\mu g/m^3$; annual geometric mean, 150 $\mu g/m^3$ 24 hour.	Applicable to alternatives that include actions that generate fugitive dust.
10. Ambient Air Standard for Lead.	Yes	--	5CCR 1001-10, Regulation 8	Monthly air concentration must be less than 1.5 $\mu g/m^3$.	Applicable to alternatives that include actions on contaminated soil that generate fugitive dust.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS (continued)

<table>
<tr><th colspan="6">STATE ARARS</th></tr>
<tr><th>Action</th><th>Potentially Applicable</th><th>Potentially Relevant and Appropriate</th><th>Citation</th><th>Description</th><th>Comments</th></tr>
<tr><td>11. Noise abatement.</td><td>Yes</td><td>--</td><td>C.R.S., Section 25-12-103</td><td>The Colorado Noise Abatement Statute provides that:
a. "Applicable activities shall be conducted in a manner so any noise produced is not objectionable due to intermittence, beat frequency, or shrillness. Noise is defined to be a public nuisance if sound levels radiating from a property line at a distance of twenty-five feet or more exceed the sound levels established for the following time periods and zones:
<table><tr><th>Zone</th><th>7:00 a.m. to next 7:00 p.m.</th><th>7:00 p.m. to next 7:00 a.m.</th></tr><tr><td>Residential</td><td>55 db(A)</td><td>50 db(A)</td></tr><tr><td>Commercial</td><td>60 db(A)</td><td>55 db(A)</td></tr><tr><td>Light Industrial</td><td>70 db(A)</td><td>65 db(A)</td></tr><tr><td>Industrial</td><td>80 db(A)</td><td>75 db(A)</td></tr></table>b. In the hours between 7:00 a.m. and the next 7:00 p.m., the noise levels permitted in Requirement a (above) may be increased by ten decibels for a period of not to exceed fifteen minutes in any one-hour period.
c. Periodic, impulsive, or shrill noises shall be considered a public nuisance when such noises are at a sound level of five decibels less than those listed in Requirement a (above).
d. Construction projects shall be subject to the maximum permissible noise levels specified for industrial zones for the period within which construction is to be completed pursuant to any applicable construction permit issued by proper authority or, if no time limitation is imposed, for a reasonable period of time for completion of the project.
e. For the purpose of this article, measurements with sound level meters shall be made when the wind velocity at the time and place of such measurement is not more than five miles per hour.</td><td>Applicable to alternatives that include construction activities.</td></tr>
</table>

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS (continued)

STATE ARARS					
Action	**Potentially Applicable**	**Potentially Relevant and Appropriate**	**Citation**	**Description**	**Comments**
12. Transportation of Hazardous Waste.	Yes	--	8 CCR 1507	Rules regarding Transportation of Hazardous Substances.	Applicable to alternatives that include transportation of contaminated soil.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS (continued)

FEDERAL ARARs					
Standard, Requirement or Criteria	**Potentially Applicable**	**Potentially Relevant and Appropriate**	**Citation**	**Description**	**Comments**
Criteria for Classification of Solid Waste and Disposal Facilities and Practices	Yes	--	40 CFR Part 257	Establishes criteria for use in determining solid wastes and disposal requirements.	Would be applicable if solid wastes are generated (such as excavated soil).
Criteria for Classification of Hazardous Waste and Disposal Facilities and Practices	Yes	--	40 CFR 264	Establishes criteria for use in determining hazardous wastes and disposal requirements. Excavated soil would be classified as D004 hazardous waste if the arsenic concentration from the TCLP test was greater than 5.0 mg/l. Excavated soil would be classified as D008 hazardous waste if the lead concentration from the TCLP test was greater than 5.0 mg/l.	Would be applicable if hazardous wastes are generated. It is noted that previous soil removed had higher concentrations of lead and arsenic and were not hazardous wastes. However, these regulations are potentially applicable.
National Ambient Air Quality Standards	No	Yes	40 CFR Part 50	Establishes ambient air quality standards for certain "criteria pollutants" to protect public health and welfare. Standards are: 150 micrograms per cubic meter for particulate matter for a 24 hour period; 50 micrograms per cubic meter for particulate matter-annual arithmetic mean; 1.5 micrograms lead per cubic meter maximum - arithmetic mean averaged over a calendar quarter	National ambient air quality standards (NAAQS) are implemented through the New Source Review Program and State Implementation Plans (SIPs). The federal New Source Review Program addresses only major sources. Emissions associated with proposed remedial action at VB/I70 OU1 would be limited to fugitive dust emissions associated with earth moving activities during construction. These activities will not constitute a major source. Therefore, attainment and maintenance of NAAQS pursuant to the New Source Review Program are not applicable. However, the standards relating to particulates and to lead are relevant and appropriate.
Hazardous Materials Transportation Regulations	Yes	--	49 CFR Parts 107, 171-177	Regulates transportation of hazardous materials.	Applicable only if the remedial action involves off-site transportation of hazardous materials. The regulations affecting packaging, labeling, marking, placarding, using proper containers, and reporting discharges of hazardous materials would be potential ARARs.

TABLE 3-4

PRELIMINARY REMEDIATION GOALS

Contaminant of Concern	Preliminary Remediation Goal	Concentration Used in FS Evaluation
Arsenic	Background Concentration	15 mg/Kg
Lead	Background Concentration	195 mg/Kg

Table 4-1
Number of Residential Properties With Lead or Arsenic Concentrations in Yard Soils Above Preliminary Action Levels

Contaminant/Concentration Range	**Number of Properties (Based on Existing Sampling Data)**	**Estimated Total Number of Properties**
Arsenic EPC> 47 mg/Kg	635	863
Arsenic EPC>240 mg/Kg	73	113
Lead EPC>208 mg/Kg	1,303	1,737
Lead EPC>540 mg/Kg	73	97

TABLE 4-2

POTENTIALLY APPLICABLE
REMEDIAL TECHOLOGIES AND PROCESS OPTIONS

GRA	Remedial Technology	Process Options
No Action	No Action	
Institutional Controls	Land Use Controls	Local Land Use Regulations Easements Restrictive Covenants
Public Health Actions	Education	Education and Outreach Program
	Monitoring	Biomonitoring for lead and arsenic
	Sampling and Response	Environmental Sampling and Response Program
Containment	Covering	Rock Geosynthetic Asphalt Concrete Multimedia Soil
	Surface Control	Soil Grading Vegetation Tilling
Removal/Disposal	Removal	Excavation
	Disposal	Onsite Offsite
	Recycle/Reuse	Offsite Recycle or Reuse
Treatment	Physical	Stabilization/Fixation Dewatering Aeration Soil Washing Acid leach washing Chelation Electro-osmosis
	Thermal	Incineration Vitrification Desorption
	Chemical	Oxidation/Reduction Neutralization Siliceous Chemicals
	Biological	Enhanced Biodegradation

TABLE 4-3
SUMMARY OF INITIAL SCREENING OF REMEDIAL TECHOLOGIES

GRA	Remedial Technology	Process Options	Results of Initial Remedial Technology Screening
No Action	No Action		Retained as required by NCP
Institutional Controls	Land Use Controls	Local Land Use Regulations Easements Restrictive Covenants	Retained
Public Health Actions	Education	Education and Outreach Program	Retained
	Monitoring	Biomonitoring for lead and arsenic	Retained
	Sampling and Response	Environmental Sampling and Response Program	Retained
Containment	Covering	Rock Geosynthetic Asphalt Concrete Multimedia Soil	Retained
	Surface Control	Soil Grading Vegetation Tilling	Retained
Removal/Disposal	Removal	Excavation	Retained
	Disposal	Onsite Offsite	Retained
	Recycle/Reuse	Offsite Recycle or Reuse	Eliminated – not applicable for the relatively low concentrations of COCs.
Treatment	Physical	Stabilization/Fixation Dewatering Aeration Soil Washing Acid leach washing Chelation Electro-osmosis	Retained
	Thermal	Incineration Vitrification Desorption	Eliminated – not applicable to arsenic or lead
	Chemical	Oxidation/Reduction Neutralization Siliceous Chemicals	Retained
	Biological	Enhanced Biodegradation	Eliminated – not applicable to arsenic or lead

TABLE 4-4

SUMMARY OF FINAL SCREENING OF
REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GRA	Remedial Technology	Process Options	Effectiveness	Implementability	Relative Costs [2]	Screening Results/Comments
No action	No action	- [1]	-	-	-	Retained as required by NCP
Institutional Controls	Land Use Controls	Local Land Use Regulations Easements Restrictive Covenants	Would not be protective because land use is already residential and would require restrictions on common activities	Would likely not be accepted by community since common activities would be restricted-	-	Eliminated from further consideration.
Public Health Actions	Education	Education and Outreach Program	Effective in modifying behavior patterns that contribute to possible exposure	Readily implementable	-	Retained
	Monitoring	Biomonitoring for lead and arsenic	Would be a key part in evaluating the effectiveness of the selected remedy.	Readily implementable	-	Retained
	Sampling and Response	Environmental Sampling and Response Program	Would be effective in addressing residual risks by identifying sources of and preventing unacceptable exposures	Readily implementable	-	Retained

TABLE 4-4 (Continued)

SUMMARY OF FINAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GRA	Remedial Technology	Process Options	Effectiveness	Implementability	Relative Costs (2)	Screening Results/Comments
Containment	Covering	Rock Geosynthetic Asphalt Concrete Multimedia Soil	Barriers would generally be effective in preventing direct contact with contaminated soil.	Would not be compatible with residential yard use.	-	Eliminated from further consideration.
	Surface Control	Soil Grading	Not effective.	-	-	Vegetation and tilling are retained for further consideration in conjunction with other remedial options.
		Vegetation	Not effective as a stand-alone option, but could be part of a comprehensive alternative.	Could be implemented in a residential yard setting.	-	
		Tilling	Not effective as a stand-alone option, but could be effective in conjunction with treatment.	Could be implemented in a residential yard setting.	-	

TABLE 4-4 (Continued)

SUMMARY OF FINAL SCREENING OF
REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GRA	Remedial Technology	Process Options	Effectiveness	Implementability	Relative Costs (2)	Screening Results/Comments
Removal/Disposal	Removal	Excavation	Effective in removing contaminated soil.	Implementable in a residential yard setting.	-	Retained.
	Disposal	Onsite	Could be effective if appropriate facility were available.	Not implementable-no onsite disposal facility exists.	-	Eliminated from further consideration.
		Offsite	Effective in preventing contact with excavated contaminated soil.	Implementable-suitable disposal facilities exist in the area.	-	Retained for further consideration.

TABLE 4-4 (Continued)

SUMMARY OF FINAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GRA	Remedial Technology	Process Options	Effectiveness	Implementability	Relative Costs (2)	Screening Results/Comments
Treatment	Physical	Stabilization/Fixation Dewatering Aeration Soil Washing Acid leach washing Chelation Electro-osmosis	Stabilization/Fixation could be effective for lead contamination, but not for arsenic. Other process options would not be effective.	Treatment would generally be difficult to implement in a residential setting, while leaving soils compatible with yard use.	-	Phosphate amendment of soils to reduce lead bioavailability is retained.
	Chemical	Oxidation/Reduction	Would not be effective.	-	-	Eliminated from further consideration.
		Neutralization	Would not be effective.	-	-	Eliminated from further consideration.
		Siliceous Chemicals	Could not be effective for lead. Not effective for arsenic.	Difficult to implement in a residential setting.		Eliminated from further consideration.

NOTES:
(1) Evaluation not performed if not required for screening purposes.
(2) Per CERCLA guidance relative cost evaluation is only performed to evaluate process options providing similar effectiveness. This was not required during the screening step for VB/I70 OU1.

TABLE 4-5

SCREENING LEVEL EVALUATION OF THE EFFECT OF TILLING ON LEAD CONCENTRATIONS IN SURFACE SOILS

Property	Average Surface Lead Concentration (mg/Kg)	Estimated Surface Concentration After 6 inch Tilling (mg/Kg)	Percent Reduction in Lead Concentration by 6 inch Tilling	Estimated Surface Concentration After 12 inch Tilling (mg/Kg)	Percent Reduction in Lead Concentration by 12 inch Tilling
1	1271	960	24%	661	48%
2	1212	729	40%	472	61%
3	450	283	37%	177	61%
4	1151	730	37%	587	49%
5	1197	942	21%	738	38%
6	198	149	25%	123	38%
7	310	326	-5%	311	-0%
8	208	204	2%	174	16%

TABLE 5-1

SUMMARY OF REMEDIAL ALTERNATIVES
VB/I70 OU1

Remedial Alternative	Contaminant/Exposure Point Concentration Range				
	Arsenic			Lead	
	47 – 128 mg/kg	128-240 mg/kg	> 240 mg/kg	208 - 540 mg/kg	> 540 mg/kg
1. No Action	No Action	No Action	No Action	No Action	No Action
2. Community Health Program, Tilling/Treatment (Lead), Targeted Removal and Disposal (Arsenic)	Community Health Program	Community Health Program	Removal and offsite disposal	Community Health Program	Tilling/Treatment with Phosphate
3. Community Health Program, Targeted Removal and Disposal	Community Health Program	Community Health Program	Removal and offsite disposal	Community Health Program	Removal and offsite disposal
4. Community Health Program, Expanded Removal and Disposal	Community Health Program	Removal and offsite disposal	Removal and offsite disposal	Community Health Program	Removal and offsite disposal
5. Removal and Disposal	Removal and offsite disposal	Removal and offsite disposal	Removal and offsite disposal	Removal and offsite disposal	Removal and offsite disposal

TABLE 7-1

SUMMARY OF COMPARATIVE ANALYSIS

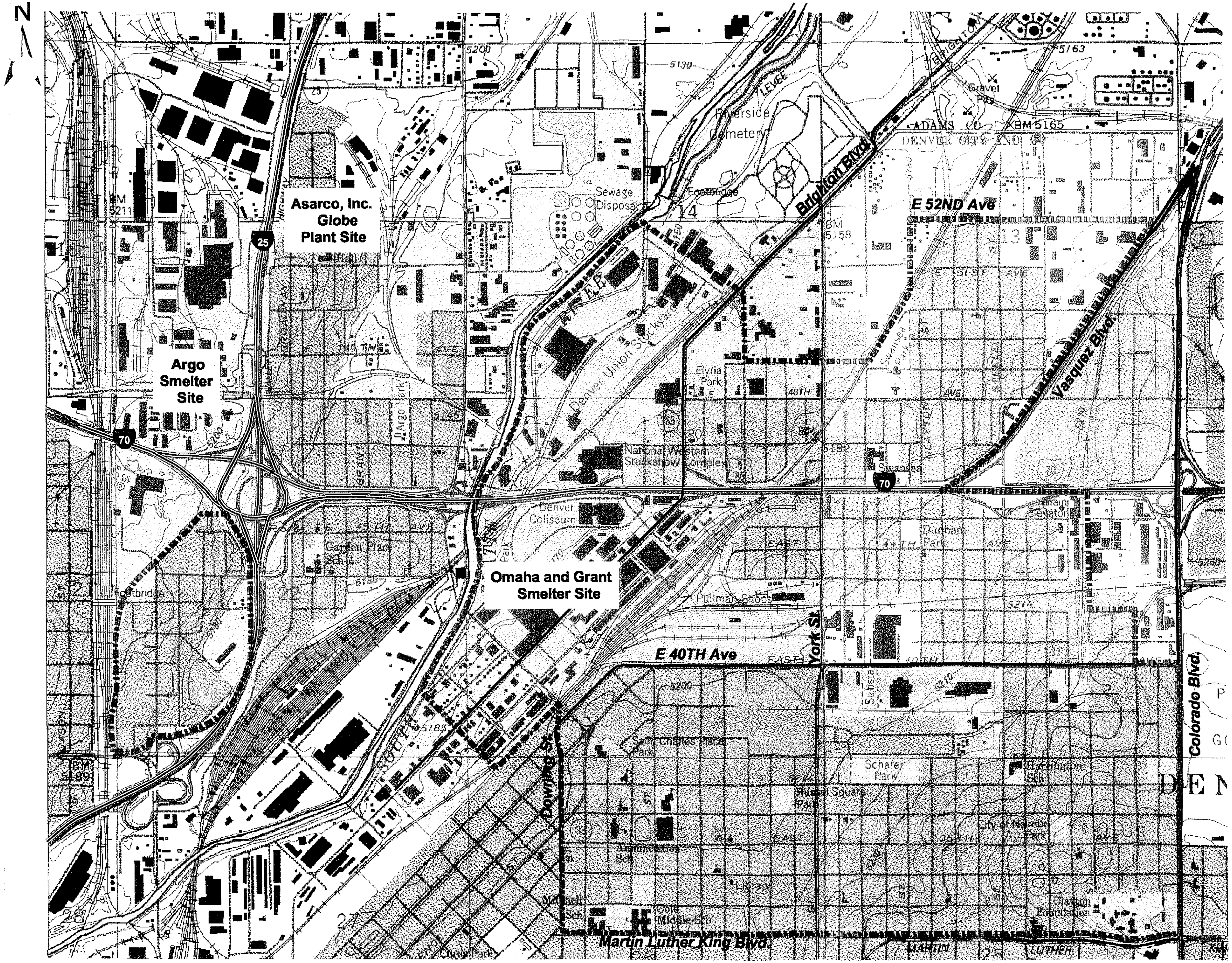
Evaluation Criterion	Alternative 2 – Community Health Program, Tilling/Treatment (Lead), Targeted Removal and Disposal (Arsenic)	Alternative 3 – Community Health Program, Targeted Removal and Disposal	Alternative 4 – Community Health Program, Expanded Removal and Disposal	Alternative 5 - Removal and Disposal
Threshold Criteria				
Overall Protection of Human Health	Meets the requirements of the RAOs – however, there is some uncertainty with respect to treatment/tilling component	Meets the requirements of the RAOs	Meets the requirements of the RAOs	Meets the requirements of the RAOs
Compliance with ARARs	Complies with ARARs	Complies with ARARs	Complies with ARARs	Complies with ARARs
Balancing Criteria				
Short-Term Effectiveness	Reduction in short-term effectiveness compared to Alternative 3, because implementation would be delayed to allow for treatability testing of tilling/phosphate treatment component and because of uncertainties associated with effectiveness of tilling/treatment	High level of short-term effectiveness	Reduction in short-term effectiveness compared to Alternative 3, because of risks associated with soil removal for properties with arsenic concentrations below RAO risk levels	Lowest level of short-term effectiveness because of risks to workers and the community during implementation – particularly associated with operation of heavy equipment and truck transportation in residential areas
Long-Term Effectiveness and Permanence	Would be effective over the long-term. Community Health Program provides additional benefit in providing a mechanism for evaluating other sources of lead	Would be effective over the long-term. Community Health Program provides additional benefit in providing a mechanism for evaluating other sources of lead	Would be effective over the long-term. Community Health Program provides additional benefit in providing a mechanism for evaluating other sources of lead	Highest possible level of long-term effectiveness for risks associated with soil because all soils with arsenic or lead above levels of concern would be removed. Would not provide information on other sources of lead. Would not reduce or prevent soil pica behavior.
Reduction of Toxicity, Mobility or Volume Through Treatment	Effectiveness of treatment with tilling expected to be effective, but there are uncertainties and site-specific testing would be required to support design	Does not contain a treatment component	Does not contain a treatment component	Does not contain a treatment component

TABLE 7-1

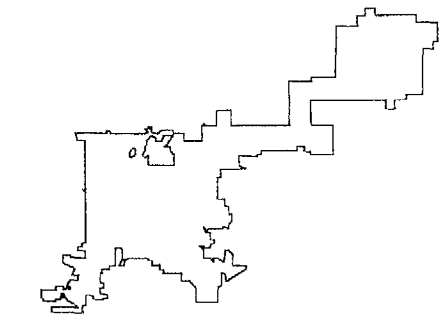
SUMMARY OF COMPARATIVE ANALYSIS (CONTINUED)

Evaluation Criterion	Alternative 2 - Tilling/Treatment (Lead), Targeted Removal and Disposal (Arsenic), Community Health Program	Alternative 3 - Targeted Removal and Disposal, Community Health Program	Alternative 4 – Expanded Removal and Disposal, Community Health Program	Alternative 5 - Removal and Disposal
Implementability	Expected to be readily implementable. However, tilling may be difficult to implement if deep tilling is required to meet RAOs. This would be evaluated during design	Readily implementable	Readily implementable	Readily implementable
Cost	$10.6 million	$11.1 million	$17.5 million	$61.0 million

FIGURES



Location of VB/I-70 Site



Washington

Legend

Study Area Boundary

Stream or River

Neighborhood

CLAYTON

COLE

ELYRIA

GLOBEVILLE

SWANSEA

Map Base:

USGS 7.5' Quadrangle

Commerce City

1,000 500 0 1,000 2,000

Feet

200 100 0 200 400 600

Meters

Vasquez Boulevard / I-70
Operable Unit 1
Remedial Investigation Report

Figure 1-1

Site Location

Project No: RAC 68-W7-0039 WA 004-RICO-089R

File: Q:\4994\1004\RI-FS\vbi70_site.eps

APPENDICES

APPENDIX A

EFFICACY OF EDUCATION-BASED COMMUNITY HEALTH PROGRAMS FOR LEAD

APPENDIX A

EFFICACY OF EDUCATION-BASED COMMUNITY HEALTH PROGRAMS FOR LEAD

Public health alternatives for lead containing elements similar to the program described above have been implemented at other sites. Data on the efficacy of those programs in reducing exposure and risk are limited, but available information supports the view that educational and outreach programs are beneficial in at least some cases. This information is summarized briefly below.

Educational Programs

Educational outreach has been implemented as a component of several programs to reduce lead exposure in children. It has been used as both the primary lead intervention strategy, and as part of comprehensive lead abatement programs.

Kimbrough et al. (1994), USEPA (1996), Schultz et al. (1999), and LCDH/UC (1993) reported that educational programs were effective in lowering the blood lead levels of exposed residents. These studies utilized in home education visits by trained personnel that addressed housecleaning methods for reducing dust-lead levels, hygiene habits for reducing lead exposures and nutritional suggestions for reducing absorption of lead. The sources of lead exposure were described and the importance of reducing lead exposures was also discussed. No other abatements were performed at these residences as part of the respective studies. The Granite City Educational Intervention Study (Kimbrough et al. 1994) reported a 47% decrease in the mean blood lead levels of study participants, four months following educational outreach activities. The Milwaukee Retrospective Educational Intervention Study (USEPA, 1996 and Schultz et al. 1999) reported that children receiving in-home educational visits had average observed blood lead levels that were 15% lower than the blood lead levels of children who did not ($p<0.001$). A 9.8% decline in the geometric mean blood lead levels was observed in children monitored as part of the Leadville/Lake County Educational Intervention Study (LCDH and UC, 1993). This study compared community blood lead concentrations in 1992 with those determined in 1991, and evaluated the effect of educational interventions on children with elevated blood lead levels (> 10 ug/dL) or children living in residences with unusually high soil concentrations of lead or arsenic. Children with elevated blood lead levels showed a 19% average decline in blood-lead concentrations. Two of these children had 49% and 57% reductions in their individual blood lead concentrations (USEPA 1998).

Education Coupled with Dust Control

Several programs have studied the effectiveness of educational programs coupled with dust control. The New Jersey Children's Lead Exposure and Reduction Study (Rhoads et al. 1997, 1999; Lioy et al. 1998) reported that a program consisting of dust control (professional cleaning) and a lead-education session program achieved a 17% decline in blood-lead concentrations in children with moderately elevated lead concentrations compared to control children ($p<0.05$). The blood lead reductions in children in the treatment group increased with the number of times their home was cleaned. However, in the Trail Dust Intervention Study (Hilts et al., 1995) implemented in British Columbia, a combined professional HEPA vacuuming and educational materials/exposure reduction intervention was not effective in reducing blood lead levels in children. The small decreases in child blood lead concentrations observed during the study were not statistically significant ($p=0.85$) between the treatment and control groups. This lack of effectiveness might be attributable to the presence of an active lead smelter in this community, providing an ongoing source of re-contamination.

Lanphear et al., (1995, 1996) and Copley (1995, 1996) reported household-dust lead levels were reduced following in-home educational outreach programs focusing on dust control. These studies provided in home instructions on cleaning to reduce dust exposure. One study provided cleaning supplies in addition to the training. As part of the Rochester Educational Intervention Study (Lanphear et al., 1995, 1996) trained individuals visited families of children with low to moderate blood-lead levels to discuss the importance of dust control to reduce lead exposure. Instructions on cleaning the home and cleaning supplies were provided to the families. The control group was only provided a brochure containing information about lead poisoning and its prevention. The median decreases in blood-lead levels for both the intervention and control groups after 7 months were less than 1 ug/dL. The median change in blood lead level for the intervention group was not statistically different from the median change observed in the control group. Although significant reductions in blood lead levels were not observed as part of this study, 30-60% reductions in dust-lead loadings were reported for most surfaces (except window wells) following cleaning. A study conducted in East St. Louis (Copley 1995) provided in-home instruction and identification of problem areas for reducing dust lead levels in homes of children with blood lead levels of 10-19 ug/dL. Lead educators provided instructions on cleaning and hygiene and contacted families throughout the study to reinforce the importance of regular cleaning. Written materials and a videotape on reducing lead exposure were also provided. Follow up samples of lead dust concentrations were collected only from homes (24/54) that reported cleaning using the recommended procedures at least once during the 3-month study period. Although blood lead levels were not measured as part of this study, a 56% decrease in the mean dust-lead loading was observed in these homes.

References

Copley C., 1995. *East St. Louis Lead Dust Reduction in Homes of At-Risk Children*. Report on Grant NE995974-01 to U.S. Environmental Protection Agency. October 1995.

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Lake County Department of Health (LCDH) and University of Cincinnati (UC), 1993. *The Leadville/Lake County Environmental Health Lead Study*. Report of the 1992 Follow-up Lead Screening. July 12, 1993.

Lioy P. J., L.Yiin, J. Adgate, C. P. Weisel, G. G. Rhoads, 1998. *The Effectiveness of a Home Cleaning Intervention Strategy in Reducing Potential Dust and Lead Exposures*. Journal of Exposure Analysis and Environmental Epidemiology. 8(1):17-35.

Schultz, B. D, and A. Murphy, 1999. *A Retrospective Examination of In-Home Educational Visits to Reduce Childhood Lead Levels*. Environmental Research. Volume 80 364-368.

Rhoads G. G., A. S. Ettinger, C. P. Weisel, T. J. Buckley, J. Adgate, and P. J. Lioy, 1999. *The Effect of Dust Control on Blood Lead in Toddlers*: A Randomized Trial. Pediatrics. 103(3):551-555.

USEPA 1998. *Review of Studies Addressing Lead Abatement Effectiveness: Updated Edition*. Prepared by Battelle for USEPA Office of Pollution Prevention and Toxics, Technical Programs Branch. EPA 747-B-98-001. December 1998.

USEPA 1996. *Effect of In-Home Educational Intervention on Children's Lead Levels in Milwaukee*. EPA Report No. 747-R-95-009. April 1996.

APPENDIX B

DETAILED COST ESTIMATES

APPENDIX B
DETAILED COST ESTIMATES

Detailed cost estimates for each action alternative are provided in Tables B-1 through B-4. Alternative 1 (No Action) is the baseline for the cost estimates for the other alternatives and is assumed to have no associated cost. These detailed estimates present the quantities made in establishing the scope of work (areas, volumes, etc.) and the calculations from which the estimated costs were derived. The unit costs shown for each work item reflect an assessment of the labor, materials and equipment required for each identified item and include allowances for appurtenant and incidental work as well as contractor overhead and profit. Unit cost rates and associated productivity factors are based on historical factors, published industry data, information on previous removals actions at the VB/I70 site, and/or experience on projects of similar scope and nature. The quantities used in assessing the scope of work are based on GIS information from the site and from quantities generated during previous removal actions. However, some uncertainties exist with respect to the potential difficulties which may be encountered and accordingly, contingency allowances have been included in the estimates, consistent with the extent of the unknowns and uncertainties. The contingency allowance is intended to cover unspecified, or unidentified, work required to be completed within the scope of work and not additional work beyond the established scope of work. Notwithstanding these unknowns, the accuracy of the estimates is anticipated to fall within the acceptable range for typical feasibility study evaluations of +50% to -30%, in accordance with EPA guidance ("A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" OSWER 9355.0-75).

B.1 Initial Remedial Action Capital Cost Estimates

The initial phase of remedial action includes engineering activities (such as soil removal/replacement or soil tilling) and setting up the Community Health Program. Detailed cost estimates were generated for: (1) soil tilling/treatment and restoration at an individual property (Table B-5); (2) soil removal and disposal and restoration at an individual property (Table B-6); and (3) setting up the Community Health Program (Table B-7).

B.2 Ongoing Remedial Action Annual Cost Estimates

After the initial phase (described above) some alternatives considered in this FS contain an ongoing Community Health Program as part of remedial action. Estimates of the annual costs for the Community Health Program were prepared for activities anticipated to be performed each year following completion of initial site remediation activities. A 30-year remedial action period has been used for costing purposes. The annual cost estimates for each alternative are included in Tables B-1 through B-3 and are presented in constant 2001 dollars. No escalation factors have been applied to future costs in performing the present worth analyses. Unit cost rates and associated productivity factors are based on published industry data, and/or experience on projects of similar scope and nature. For the Community Health Program a baseline annual cost was estimated (Table B-8). It was assumed that the scope of this program would be reduced during the 30-year remedial action period, as health risks were identified and addressed. For the purposes of costing it was assumed that the cost of the program would reduce to 75% of the initial annual cost after 5 years, and to 33% of the initial cost after 10 years.

B.3 Periodic Costs

For the alternatives considered in this FS the only periodic costs are associated with 5-year reviews. As specified in EPA guidance (EPA, 1988a), a 30-year period has been used for costing purposes. The 5-year review cost estimates for each alternative are included in Tables B-1 through B-3 and are presented in constant 2001 dollars. No escalation factors have been applied to future costs in performing the present worth analyses. Unit cost rates and associated productivity factors are based on published industry data, and/or experience on projects of similar scope and nature.

B.4 Operation and Maintenance Costs

There are no Operation and Maintenance costs associated with any of the alternatives – all activities are considered to be part of remedial action.

B.5 Present Worth Calculations

Present worth analyses were performed on estimated costs associated with each remedial alternative to provide a common basis for comparison. Present worth analysis calculates a current value, or worth, of all costs incurred in the present or at some future date at an assumed constant rate of return, or discount rate. The present worth calculated represents an amount, which if invested in 2001 at a certain rate of return would yield the appropriate dollar amount to meet the required expenditures over the construction and 30-year remedial action periods. The exact duration of initial implementation and corresponding capital costs will be dependent on the results of the remedial design phase. At that time the most appropriate implementation scenario can be developed. However, the assumed durations are reasonable and allow for an objective, relative comparison of the alternatives.

Because total remedial action costs could be especially sensitive to the prevailing rate of return used in the present worth analyses, rates of return of 3%, 5%, and 10% were used to prepare present worth estimates for each alternative. The capital costs spread out over the anticipated implementation period were also discounted to constant 2001 dollars using rates of return of 3%, 5%, and 10%. For simplicity, only the present worth calculated at an assumed 5% rate of return has been presented in the text and used in the comparison of costs. The present worth analyses performed in this report are considered before-tax analyses and do not consider future escalation of costs. The expenditure of remedial action and 5-year review costs and subsequent present worth analyses for the alternatives are presented in Tables B-9 through B-12.

TABLE B-1

DETAILED COST ESTIMATE
VASQUEZ BOULEVARD/I-70 SITE OU1
ALTERNATIVE 2 - COMMUNITY HEALTH PROGRAM, TILLING/TREATMENT (LEAD), TARGETED REMOVAL AND DISPOSAL (ARSENIC)

Item/Description	Quantity	Unit	Unit Cost	Extension	Total Cost
INITIAL REMEDIAL ACTION DIRECT CAPITAL COSTS					
Tilling & Treatment	89	Property	$15,487		$1,378,346
Removal/Disposal	113	Property	$18,412		$2,080,556
Community Health Program	1	LS	$205,655		$205,655
SUBTOTAL INITIAL REMEDIAL ACTION DIRECT CAPITAL COSTS					$3,664,557
INDIRECT INITIAL REMEDIAL ACTION CAPITAL COSTS					
Mob/Demob			10%	$366,455.73	
Engineering/Administration Costs			10%	$366,455.73	
Construction Management Costs			15%	$549,683.59	
Health & Safety			3%	$109,936.72	
SUBTOTAL INITIAL REMEDIAL ACTION INDIRECT CAPITAL COSTS					$1,392,532
Capital Cost Contingency			25%	$1,264,272.27	
TOTAL ESTIMATED CAPITAL COST FOR INITIAL REMEDIAL ACTION					$6,321,361
ONGOING REMEDIAL ACTION ANNUAL COSTS					
Community Health Program	1	Yr	$328,645		$328,645
SUBTOTAL ONGOING REMEDIAL ACTION ANNUAL COSTS					$328,645
Administrative Costs			10%	$32,864.50	
Contingency			25%	$90,377.38	
TOTAL ONGOING REMEDIAL ACTION ANNUAL COSTS					$451,887
PERIODIC COSTS - FIVE YEAR REVIEWS					
Labor - 2 Engineers ($70/hr) & 2 Technicians ($50/hr) - 1 week @ 40 hrs/wk	40	mh	$240	$9,600.00	
Travel	4	each	$50	$200.00	
Lab Costs	15	each	$500	$7,500.00	
Office/Admin	60	mh	$140	$8,400.00	
SUBTOTAL PERIODIC COSTS					$25,700
Periodic Cost Contingency			10%	$2,570.00	
TOTAL FIVE YEAR REVIEW COSTS					$28,270
TOTAL PRESENT WORTH (5% rate of return, 30 year period)					$10,559,000

NOTES:

Total Present Worth calculation presented in Table B-9.

TABLE B-2

DETAILED COST ESTIMATE
VASQUEZ BOULEVARD/I-70 SITE OU1
ALTERNATIVE 3 - COMMUNITY HEALTH PROGRAM, TARGETED REMOVAL AND DISPOSAL

Item/Description	Quantity	Unit	Unit Cost	Extension	Total Cost
INITIAL REMEDIAL ACTION DIRECT CAPITAL COSTS					
Removal & Disposal	202	property	$18,412		$3,719,224
Community Health Program	1	LS	$205,655		$205,655
SUBTOTAL INITIAL REMEDIAL ACTION DIRECT CAPITAL COSTS					$3,924,879
INDIRECT INITIAL REMEDIAL ACTION CAPITAL COSTS					
Mob/Demob			10%	$392,488	
Engineering/Administration Costs			10%	$392,488	
Construction Management Costs			15%	$588,732	
Health & Safety			3%	$117,746	
SUBTOTAL INITIAL REMEDIAL ACTION INDIRECT CAPITAL COSTS					$1,491,454
Capital Cost Contingency			25%	$1,354,083	
TOTAL ESTIMATED CAPITAL COST FOR INITIAL REMEDIAL ACTION					$6,770,416
ONGOING REMEDIAL ACTION ANNUAL COSTS					
Ongoing Remedial Action Annual Costs					
Same as Alternative 2					$328,645
SUBTOTAL ONGOING REMEDIAL ACTION ANNUAL COSTS					$328,645
Administrative Costs			10%	$32,865	
Contingency			25%	$90,377	
TOTAL ONGOING REMEDIAL ACTION ANNUAL COSTS					$451,887
PERIODIC COSTS - FIVE YEAR REVIEWS					
Same as Alternative 2					
SUBTOTAL PERIODIC COSTS					$25,700
Contingency			10%	$2,570	
TOTAL PERIODIC COSTS					$28,270
TOTAL PRESENT WORTH (5% rate of return, 30 year period)					$11,096,000

NOTES:

Total Present Worth calculation presented in Table B-10.

TABLE B-3

DETAILED COST ESTIMATE
VASQUEZ BOULEVARD/I-70 SITE OU1
ALTERNATIVE 4 - COMMUNITY HEALTH PROGRAM, EXPANDED REMOVAL AND DISPOSAL

Item/Description	Quantity	Unit	Unit Cost	Extension	Total Cost
INITIAL REMEDIAL ACTION DIRECT CAPITAL COSTS					
Removal & Disposal	403	property	$18,412		$7,420,036
Community Health Program	1	LS	$205,655		$205,655
SUBTOTAL INITIAL REMEDIAL ACTION DIRECT CAPITAL COSTS					$7,625,691
INDIRECT INITIAL REMEDIAL ACTION CAPITAL COSTS					
Mob/Demob			10%	$762,569	
Engineering/Administration Costs			10%	$762,569	
Construction Management Costs			15%	$1,143,854	
Health & Safety			3%	$228,771	
SUBTOTAL INITIAL REMEDIAL ACTION INDIRECT CAPITAL COSTS					$2,897,763
Capital Cost Contingency			25%	$2,630,863	
TOTAL ESTIMATED CAPITAL COST FOR INITIAL REMEDIAL ACTION					$13,154,317
ONGOING REMEDIAL ACTION ANNUAL COSTS					
Ongoing Remedial Action Annual Costs					
Same as Alternative 2					$328,645
SUBTOTAL ONGOING REMEDIAL ACTION ANNUAL COSTS					$328,645
Administrative Costs			10%	$32,865	
Contingency			25%	$90,377	
TOTAL ONGOING REMEDIAL ACTION ANNUAL COSTS					$451,887
PERIODIC COSTS - FIVE YEAR REVIEWS					
Same as Alternative 2					
SUBTOTAL FIVE YEAR REVIEW COSTS					$25,700
Five Year Review Contingency			10%	$2,570	
TOTAL FIVE YEAR REVIEW COSTS					$28,270
TOTAL PRESENT WORTH (5% rate of return, 30 year period)					$17,480,000

NOTES:

Total Present Worth calculation presented in Table B-11.

TABLE B-4

DETAILED COST ESTIMATE
VASQUEZ BOULEVARD/I-70 SITE OU1
ALTERNATIVE 5 - REMOVAL AND DISPOSAL

Item/Description	Quantity	Unit	Unit Cost	Extension	Total Cost
DIRECT CAPITAL COSTS					
Sampling and Analysis at Unsampled Properties	1000	Property	$500		$500,000
Removal & Disposal - Lead Only Above Action Level	1259	Property	$18,412		$23,180,708
Removal & Disposal - Arsenic Only Above Action Level	384	Property	$18,412		$7,070,208
Removal & Disposal - Both Lead and Arsenic Above Action Levels	479	Property	$18,412		$8,819,348
SUBTOTAL DIRECT CAPITAL COSTS					$39,570,264
INDIRECT CAPITAL COSTS					
Mob/Demob			10%	$3,957,026	
Engineering/Administration Costs			10%	$3,957,026	
Construction Management Costs			15%	$5,935,540	
Health & Safety			3%	$1,187,108	
SUBTOTAL INDIRECT CAPITAL COSTS					$15,036,700
Capital Cost Contingency			20%	$10,921,393	
TOTAL ESTIMATED CAPITAL COST					$65,528,357
PERIODIC COSTS - FIVE YEAR REVIEWS					
None					
SUBTOTAL FIVE YEAR REVIEW COSTS					$0
Five Year Review Contingency			10%	$0	
TOTAL FIVE YEAR REVIEW COSTS					$0
TOTAL PRESENT WORTH (5% rate of return, 4 year period)					$60,995,000

NOTES:

Total Present Worth calculation presented in Table B-12..

TABLE B-5

DETAILED CONSTRUCTION COST ESTIMATE FOR SOIL TILLING/TREATMENT PER RESIDENTIAL YARD
VASQUEZ BOULEVARD/I-70 SITE OU1

Item/Description	Quantity	Unit	Unit Cost	Extension
DIRECT CAPITAL COSTS				
Site Preparation	1	ls	$750.00	$750.00
Tilling	580	sy	$5.00	$2,900.00
Treatment Chemical Purchase	9,704	lb	$0.25	$2,425.93
Chemical handling and application	9,704	lb	$0.30	$2,911.11
Property Restoration	1	LS	$2,500.00	$2,500.00
Post-Remedy Testing	1	LS	$4,000.00	$4,000.00
TOTAL ESTIMATED CAPITAL COST				$15,487.04

Assumptions

1) Area of soils estimated at 580 square yards (Washington Group, 2001b).
2) Treatment chemical P2O5 cost $ 450 per ton.
3) Target concentration 1% P in treated soil = 0.01 * 5240 feet * 0.5 feet * 100 lbs per cubic foot = 2,620 lbs of P. = 2,620/0.27 lbs of P2O5

TABLE B-6

DETAILED CONSTRUCTION COST ESTIMATE FOR SOIL REMOVAL & DISPOSAL PER RESIDENTIAL YARD
VASQUEZ BOULEVARD/I-70 SITE OU1

Item/Description	Quantity	Unit	Unit Cost	Extension
DIRECT CAPITAL COSTS				
Site Preparation	1	LS	$750.00	$750
Soil Removal	194	cy	$18.00	$3,492
Transport/ Dispose Excavated Soil	194	cy	$16.00	$3,104
Purchase/Transport Clean Fill	194	cy	$19.00	$3,686
Place & Grade Clean Fill	194	cy	$20.00	$3,880
Property Restoration	1	LS	$3,500.00	$3,500
SUBTOTAL DIRECT CAPITAL COSTS				$18,412

Assumptions

1) Volume of soils estimated at 5,240 square feet excavation areas at a property, 1 foot depth (= 194 cubic yards per property).

Table B-7
Detailed Cost Estimate for Community Health Program Setup

	Labor			Materials				Services				
	Person-hours	Avg. Rate	Cost	Quantity	Units	Unit Cost	Cost	Quantity	Units	Unit Cost	Cost	Total
Community Health Program One-Time Start-Up Costs												
1 Education/Public Awareness												
Develop Public Awareness Campaign	400	$90	$36,000	10000	brochures	$2	$20,000	1	art work	$10,000	$10,000	$66,000
Newspaper												
- News/Post								1	ad budget	$6,000	$6,000	$6,000
- LaVoz								1	ad budget	$2,400	$2,400	$2,400
Direct Mail Fact Sheet				4000	fact sheet	$2	$8,000	1	mailing	$1,500	$1,500	$9,500
Task Subtotal	400		$36,000									
2 Biomonitoring Program												
Develop clinic-based biomonitoring program												
- Health Sciences Professional	180	$75	$13,500									$13,500
- Information System Development	320	$75	$24,000									$24,000
Documentation of program	160	$85	$13,600	10	copies	$50	$500					$14,100
Clinic facilities set up	120	$65	$7,800	1	supplies	$5,000	$5,000					$12,800
Task Subtotal	780		$58,900									
3 Source Investigation and Remediation												
Develop sampling and remediation program	200	$85	$17,000									$17,000
Program documentation	160	$85	$13,600	10	copies	$50	$500					$14,100
Task Subtotal	360		$30,600									
4 Program Introduction												
Public Meeting												
- Health Sciences Professional	60	$85	$5,100									$5,100
- Health Sciences Professional	60	$75	$4,500									$4,500
- Hall Rental (Community Center)								2		$150	$300	$300
- AV Equipment								2		$50	$100	$100
- Direct Mail Fact Sheet				4000	fact sheets	$2	$8,000	1	mailing	$1,500	$1,500	$9,500
Task Subtotal	120		$9,600									
Subtotal	**1660**		**$135,100**				**$42,000**				**$21,800**	**$198,900**
Project Management (5% of labor)			$6,755									+ $6,755
Total Start Up Costs			**$141,855**				**$42,000**				**$21,800**	**$205,655**

Table B-8
Detailed Annual Cost Estimate for
Community Health Program

		Labor			Materials				Services				
		Person-hours	Avg. Rate	Cost	Quantity	Units	Unit Cost	Cost	Quantity	Units	Unit Cost	Cost	Annual Total
Community Health Program Annual Costs													
1 Education/Public Awareness													
Public education and outreach		168	$80	$13,440	4000	brochures	$1	$4,000					$17,440
Awareness promotions		100	$80	$8,000					1	promo.	$3,500	$3,500	$11,500
Newspaper advertisements													
- News/Post									1	ad budget	$1,200	$1,200	$1,200
- LaVoz									1	ad budget	$600	$600	$600
Direct mail									1	mailing	$1,500	$1,500	$1,500
Task Subtotal		268		$21,440									
2 Ongoing Clinic-based Biomonitoring													
Implement clinic based biomonitoring program													
- Blood lead sampling & analysis		400	$65	$26,000					700	samples	$35	$24,500	$50,500
- Urine arsenic sampling & analysis		400	$65	$26,000					700	samples	$45	$31,500	$57,500
- Participation Incentives	EE Series Savings Bonds				100	bonds	$25	$2,500					$2,500
Case management services		400	$65	$26,000									$26,000
Database/Records Management		400	$45	$18,000									$18,000
Clinic facilities									4	months	$1,000	$4,000	$4,000
Task Subtotal		1600		$96,000									
3 Source Investigation and Remediation													
Implement ongoing sampling program	33/yr	400	$95	$38,000									$38,000
- Interior dust/exterior paint lead samples	4 hr/res	132	$65	$8,580					66	samples	$15	$990	$9,570
- Soil lead & arsenic samples	6 hr/res	198	$65	$12,870					99	samples	$35	$3,465	$16,335
- Administer questionnaire	1 hr/residence	33	$65	$2,145									$2,145
Yard Remediation (including exterior paint abatement) when necessary	1/yr								1	property	$45,000	$45,000	$45,000
Task Subtotal		763		$61,595									
Annual Subtotal		**2631**		**$179,035**				**$6,500**				**$116,255**	**$301,790**
Health & Safety (10% of labor)				$17,904									+ $17,904
Project Management (5% of labor)				$8,952									+ $8,952
Annual Total				**$205,890**				**$6,500**				**$116,255**	**$328,645**

TABLE B-9

PRESENT WORTH ANALYSIS
VASQUEZ BOULEVARD/I-70 SITE OU1
ALTERNATIVE 2 - COMMUNITY HEALTH PROGRAM, TILLING/TREATMENT (LEAD), TARGETED REMOVAL AND DISPOSAL (ARSENIC)

Year	Capital Costs	Ongoing Costs	Total Annual Expenditure	Rate of Return = 3%		Rate of Return = 5%		Rate of Return = 10%	
				Discount Factor	Present Worth	Discount Factor	Present Worth	Discount Factor	Present Worth
0	$6,321,361	$0	$6,321,361	1.0000	$6,321,361	1.0000	$6,321,361	1.0000	$6,321,361
1		$451,887	$451,887	0.9709	$438,725	0.9524	$430,368	0.9091	$410,806
2		$451,887	$451,887	0.9426	$425,947	0.9070	$409,875	0.8264	$373,460
3		$451,887	$451,887	0.9151	$413,541	0.8638	$390,357	0.7513	$339,509
4		$451,887	$451,887	0.8885	$401,496	0.8227	$371,768	0.6830	$308,645
5		$367,185	$367,185	0.8626	$316,737	0.7835	$287,699	0.6209	$227,993
6		$338,915	$338,915	0.8375	$283,836	0.7462	$252,904	0.5645	$191,309
7		$338,915	$338,915	0.8131	$275,569	0.7107	$240,861	0.5132	$173,917
8		$338,915	$338,915	0.7894	$267,543	0.6768	$229,391	0.4665	$158,106
9		$338,915	$338,915	0.7664	$259,750	0.6446	$218,468	0.4241	$143,733
10		$367,185	$367,185	0.7441	$273,220	0.6139	$225,420	0.3855	$141,566
11		$149,123	$149,123	0.7224	$107,729	0.5847	$87,189	0.3505	$52,267
12		$149,123	$149,123	0.7014	$104,592	0.5568	$83,037	0.3186	$47,515
13		$149,123	$149,123	0.6810	$101,545	0.5303	$79,083	0.2897	$43,196
14		$149,123	$149,123	0.6611	$98,588	0.5051	$75,317	0.2633	$39,269
15		$177,393	$177,393	0.6419	$113,862	0.4810	$85,329	0.2394	$42,466
16		$149,123	$149,123	0.6232	$92,928	0.4581	$68,315	0.2176	$32,453
17		$149,123	$149,123	0.6050	$90,222	0.4363	$65,062	0.1978	$29,503
18		$149,123	$149,123	0.5874	$87,594	0.4155	$61,964	0.1799	$26,821
19		$149,123	$149,123	0.5703	$85,043	0.3957	$59,013	0.1635	$24,383
20		$177,393	$177,393	0.5537	$98,218	0.3769	$66,857	0.1486	$26,368
21		$149,123	$149,123	0.5375	$80,161	0.3589	$53,526	0.1351	$20,151
22		$149,123	$149,123	0.5219	$77,826	0.3418	$50,978	0.1228	$18,319
23		$149,123	$149,123	0.5067	$75,559	0.3256	$48,550	0.1117	$16,654
24		$149,123	$149,123	0.4919	$73,358	0.3101	$46,238	0.1015	$15,140
25		$177,393	$177,393	0.4776	$84,724	0.2953	$52,385	0.0923	$16,373
26		$149,123	$149,123	0.4637	$69,147	0.2812	$41,939	0.0839	$12,512
27		$149,123	$149,123	0.4502	$67,133	0.2678	$39,942	0.0763	$11,375
28		$149,123	$149,123	0.4371	$65,178	0.2551	$38,040	0.0693	$10,341
29		$149,123	$149,123	0.4243	$63,280	0.2429	$36,229	0.0630	$9,401
30		$177,393	$177,393	0.4120	$73,083	0.2314	$41,045	0.0573	$10,166
TOTAL PRESENT WORTH				@ 3% $11,387,000		@ 5% $10,559,000		@ 10% $9,295,000	

TABLE B-10

PRESENT WORTH ANALYSIS
VASQUEZ BOULEVARD/I-70 SITE OU1
ALTERNATIVE 3 - COMMUNITY HEALTH PROGRAM, TARGETED REMOVAL AND DISPOSAL

Year	Capital Costs	Ongoing Costs	Total Annual Expenditure	Rate of Return = 3% Discount Factor	Rate of Return = 3% Present Worth	Rate of Return = 5% Discount Factor	Rate of Return = 5% Present Worth	Rate of Return = 10% Discount Factor	Rate of Return = 10% Present Worth
0	$6,770,416	$0	$6,770,416	1.0000	$6,770,416	1.0000	$6,770,416	1.0000	$6,770,416
1		$451,887	$451,887	0.9709	$438,725	0.9524	$430,368	0.9091	$410,806
2		$451,887	$451,887	0.9426	$425,947	0.9070	$409,875	0.8264	$373,460
3		$451,887	$451,887	0.9151	$413,541	0.8638	$390,357	0.7513	$339,509
4		$451,887	$451,887	0.8885	$401,496	0.8227	$371,768	0.6830	$308,645
5		$480,157	$480,157	0.8626	$414,188	0.7835	$376,215	0.6209	$298,140
6		$338,915	$338,915	0.8375	$283,836	0.7462	$252,904	0.5645	$191,309
7		$338,915	$338,915	0.8131	$275,569	0.7107	$240,861	0.5132	$173,917
8		$338,915	$338,915	0.7894	$267,543	0.6768	$229,391	0.4665	$158,106
9		$338,915	$338,915	0.7664	$259,750	0.6446	$218,468	0.4241	$143,733
10		$367,185	$367,185	0.7441	$273,220	0.6139	$225,420	0.3855	$141,566
11		$149,123	$149,123	0.7224	$107,729	0.5847	$87,189	0.3505	$52,267
12		$149,123	$149,123	0.7014	$104,592	0.5568	$83,037	0.3186	$47,515
13		$149,123	$149,123	0.6810	$101,545	0.5303	$79,083	0.2897	$43,196
14		$149,123	$149,123	0.6611	$98,588	0.5051	$75,317	0.2633	$39,269
15		$177,393	$177,393	0.6419	$113,862	0.4810	$85,329	0.2394	$42,466
16		$149,123	$149,123	0.6232	$92,928	0.4581	$68,315	0.2176	$32,453
17		$149,123	$149,123	0.6050	$90,222	0.4363	$65,062	0.1978	$29,503
18		$149,123	$149,123	0.5874	$87,594	0.4155	$61,964	0.1799	$26,821
19		$149,123	$149,123	0.5703	$85,043	0.3957	$59,013	0.1635	$24,383
20		$177,393	$177,393	0.5537	$98,218	0.3769	$66,857	0.1486	$26,368
21		$149,123	$149,123	0.5375	$80,161	0.3589	$53,526	0.1351	$20,151
22		$149,123	$149,123	0.5219	$77,826	0.3418	$50,978	0.1228	$18,319
23		$149,123	$149,123	0.5067	$75,559	0.3256	$48,550	0.1117	$16,654
24		$149,123	$149,123	0.4919	$73,358	0.3101	$46,238	0.1015	$15,140
25		$177,393	$177,393	0.4776	$84,724	0.2953	$52,385	0.0923	$16,373
26		$149,123	$149,123	0.4637	$69,147	0.2812	$41,939	0.0839	$12,512
27		$149,123	$149,123	0.4502	$67,133	0.2678	$39,942	0.0763	$11,375
28		$149,123	$149,123	0.4371	$65,178	0.2551	$38,040	0.0693	$10,341
29		$149,123	$149,123	0.4243	$63,280	0.2429	$36,229	0.0630	$9,401
30		$177,393	$177,393	0.4120	$73,083	0.2314	$41,045	0.0573	$10,166
TOTAL PRESENT WORTH				@3%	$11,934,000	@5%	$11,096,000	@10%	$9,814,000

TABLE B-11

PRESENT WORTH ANALYSIS
VASQUEZ BOULEVARD/I-70 SITE OU1
ALTERNATIVE 4 - COMMUNITY HEALTH PROGRAM, EXPANDED REMOVAL AND DISPOSAL

Year	Capital Costs	Ongoing Costs	Total Annual Expenditure	Rate of Return = 3% Discount Factor	Rate of Return = 3% Present Worth	Rate of Return = 5% Discount Factor	Rate of Return = 5% Present Worth	Rate of Return = 10% Discount Factor	Rate of Return = 10% Present Worth
0	$13,154,317	$0	$13,154,317	1.0000	$13,154,317	1.0000	$13,154,317	1.0000	$13,154,317
1		$451,887	$451,887	0.9709	$438,725	0.9524	$430,368	0.9091	$410,806
2		$451,887	$451,887	0.9426	$425,947	0.9070	$409,875	0.8264	$373,460
3		$451,887	$451,887	0.9151	$413,541	0.8638	$390,357	0.7513	$339,509
4		$451,887	$451,887	0.8885	$401,496	0.8227	$371,768	0.6830	$308,645
5		$480,157	$480,157	0.8626	$414,188	0.7835	$376,215	0.6209	$298,140
6		$338,915	$338,915	0.8375	$283,836	0.7462	$252,904	0.5645	$191,309
7		$338,915	$338,915	0.8131	$275,569	0.7107	$240,861	0.5132	$173,917
8		$338,915	$338,915	0.7894	$267,543	0.6768	$229,391	0.4665	$158,106
9		$338,915	$338,915	0.7664	$259,750	0.6446	$218,468	0.4241	$143,733
10		$367,185	$367,185	0.7441	$273,220	0.6139	$225,420	0.3855	$141,566
11		$149,123	$149,123	0.7224	$107,729	0.5847	$87,189	0.3505	$52,267
12		$149,123	$149,123	0.7014	$104,592	0.5568	$83,037	0.3186	$47,515
13		$149,123	$149,123	0.6810	$101,545	0.5303	$79,083	0.2897	$43,196
14		$149,123	$149,123	0.6611	$98,588	0.5051	$75,317	0.2633	$39,269
15		$177,393	$177,393	0.6419	$113,862	0.4810	$85,329	0.2394	$42,466
16		$149,123	$149,123	0.6232	$92,928	0.4581	$68,315	0.2176	$32,453
17		$149,123	$149,123	0.6050	$90,222	0.4363	$65,062	0.1978	$29,503
18		$149,123	$149,123	0.5874	$87,594	0.4155	$61,964	0.1799	$26,821
19		$149,123	$149,123	0.5703	$85,043	0.3957	$59,013	0.1635	$24,383
20		$177,393	$177,393	0.5537	$98,218	0.3769	$66,857	0.1486	$26,368
21		$149,123	$149,123	0.5375	$80,161	0.3589	$53,526	0.1351	$20,151
22		$149,123	$149,123	0.5219	$77,826	0.3418	$50,978	0.1228	$18,319
23		$149,123	$149,123	0.5067	$75,559	0.3256	$48,550	0.1117	$16,654
24		$149,123	$149,123	0.4919	$73,358	0.3101	$46,238	0.1015	$15,140
25		$177,393	$177,393	0.4776	$84,724	0.2953	$52,385	0.0923	$16,373
26		$149,123	$149,123	0.4637	$69,147	0.2812	$41,939	0.0839	$12,512
27		$149,123	$149,123	0.4502	$67,133	0.2678	$39,942	0.0763	$11,375
28		$149,123	$149,123	0.4371	$65,178	0.2551	$38,040	0.0693	$10,341
29		$149,123	$149,123	0.4243	$63,280	0.2429	$36,229	0.0630	$9,401
30		$177,393	$177,393	0.4120	$73,083	0.2314	$41,045	0.0573	$10,166
TOTAL PRESENT WORTH				@ 3%	$18,318,000	@ 5%	$17,480,000	@ 10%	$16,198,000

TABLE B-12

PRESENT WORTH ANALYSIS
VASQUEZ BOULEVARD/I-70 SITE OU1
ALTERNATIVE 5 - REMOVAL AND DISPOSAL

Year	Capital Costs	Ongoing Costs	Total Annual Expenditure	Rate of Return = 3%		Rate of Return = 5%		Rate of Return = 10%	
				Discount Factor	Present Worth	Discount Factor	Present Worth	Discount Factor	Present Worth
0	$16,382,089	$0	$16,382,089	1.0000	$16,382,089	1.0000	$16,382,089	1.0000	$16,382,089
1	$16,382,089	$0	$16,382,089	0.9709	$15,904,941	0.9524	$15,601,990	0.9091	$14,892,808
2	$16,382,089	$0	$16,382,089	0.9426	$15,441,690	0.9070	$14,859,038	0.8264	$13,538,917
3	$16,382,089	$0	$16,382,089	0.9151	$14,991,932	0.8638	$14,151,465	0.7513	$12,308,106
4		$0	$0	0.8885	$0	0.8227	$0	0.6830	$0
5		$0	$0	0.8626	$0	0.7835	$0	0.6209	$0
6		$0	$0	0.8375	$0	0.7462	$0	0.5645	$0
7		$0	$0	0.8131	$0	0.7107	$0	0.5132	$0
8		$0	$0	0.7894	$0	0.6768	$0	0.4665	$0
9		$0	$0	0.7664	$0	0.6446	$0	0.4241	$0
10		$0	$0	0.7441	$0	0.6139	$0	0.3855	$0
11		$0	$0	0.7224	$0	0.5847	$0	0.3505	$0
12		$0	$0	0.7014	$0	0.5568	$0	0.3186	$0
13		$0	$0	0.6810	$0	0.5303	$0	0.2897	$0
14		$0	$0	0.6611	$0	0.5051	$0	0.2633	$0
15		$0	$0	0.6419	$0	0.4810	$0	0.2394	$0
16		$0	$0	0.6232	$0	0.4581	$0	0.2176	$0
17		$0	$0	0.6050	$0	0.4363	$0	0.1978	$0
18		$0	$0	0.5874	$0	0.4155	$0	0.1799	$0
19		$0	$0	0.5703	$0	0.3957	$0	0.1635	$0
20		$0	$0	0.5537	$0	0.3769	$0	0.1486	$0
21		$0	$0	0.5375	$0	0.3589	$0	0.1351	$0
22		$0	$0	0.5219	$0	0.3418	$0	0.1228	$0
23		$0	$0	0.5067	$0	0.3256	$0	0.1117	$0
24		$0	$0	0.4919	$0	0.3101	$0	0.1015	$0
25		$0	$0	0.4776	$0	0.2953	$0	0.0923	$0
26		$0	$0	0.4637	$0	0.2812	$0	0.0839	$0
27		$0	$0	0.4502	$0	0.2678	$0	0.0763	$0
28		$0	$0	0.4371	$0	0.2551	$0	0.0693	$0
29		$0	$0	0.4243	$0	0.2429	$0	0.0630	$0
30		$0	$0	0.4120	$0	0.2314	$0	0.0573	$0
TOTAL PRESENT WORTH				@ 3% $62,721,000		@ 5% $60,995,000		@ 10% $57,122,000	

APPENDIX C

MANAGEMENT OF RISKS ASSOCIATED WITH LEAD AND ARSENIC IN RESIDENTIAL SOILS, VASQUEZ BOULEVARD/INTERSTATE 70 SUPERFUND SITE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
999 18TH STREET - SUITE 300
DENVER, CO 80202-2466
http://www.epa.gov/region08

October 19, 2001

Ref: 8EPR-SR

MEMORANDUM

Subject: Management of Risks Associated with Lead and Arsenic in Residential Soils, Vasquez Boulevard/Interstate 70 Superfund Site

From: Bonnie Lavelle
Remedial Project Manager

To: Administrative Record File

The purpose of this memorandum is to provide the basis for EPA's determination that remedial action is necessary to address unacceptable human health risks associated with potential exposure to lead and arsenic in the residential soils Operable Unit 1 of the Vasquez Boulevard/Interstate 70 (VB/I70) Superfund Site. This memorandum also provides the basis for VB/I70 Site-specific preliminary action levels for lead and arsenic in residential soil.

Human Health Risks Associated with Potential Exposure to Arsenic

EPA completed a quantitative baseline human health risk assessment (EPA, 2001a) which evaluated current and anticipated future exposure of residents within VB/I70 Site Operable Unit 1 to concentrations of arsenic measured in soil collected from their yards. The reasonably anticipated future land use of the residential area of VB/I70 is residential. It is not expected that the current land use will change. The exposure pathways of concern to residents are incidental ingestion of soil and dust, ingestion of home grown garden vegetables, and intentional ingestion of large amounts of soil by children with soil pica behavior. The adverse health effects associated with arsenic exposure that were considered by EPA are:

- Acute non-cancer effects (irritation of the gastrointestinal tract leading to nausea and vomiting). EPA evaluated the risk that such effects could potentially result from a one-time exposure to arsenic by a child with soil pica behavior who happens to ingest soil from a small area of a yard that contains arsenic levels higher than the average concentration in the yard.

- Subchronic non-cancer effects (diarrhea, vomiting, anemia, injury to blood vessels, damage to kidney and liver, and impaired nerve function). EPA evaluated the risk that such effects could potentially result from lower level exposure for periods of a few months to several years by a child who plays preferentially in a small area of a yard during the summer months and happens to incidentally ingest soil at a rate characteristic of the upper percentile of the general population.

- Chronic non-cancer effects (similar to subchronic effects but also include skin abnormalities). EPA evaluated the risk that such effects could potentially result from lower level exposure over a long period of time such as that associated with long term incidental ingestion of soil and dust and ingestion of home grown garden vegetables by long time area residents who have spent their childhood and adult years living at the same residence.

- Chronic cancer effects (skin cancer, internal cancer including cancer of the bladder and lung). EPA evaluated the risk that such effects could potentially result from lower level exposure over a long period of time such as that associated with long term incidental ingestion of soil and dust and ingestion of home grown garden vegetables by long time area residents who have spent their childhood and adult years living at the same residence.

The baseline human health risk assessment quantified potential risks to residents with average levels of exposure and to residents with "reasonable maximum" levels of exposure. The intent of the reasonable maximum exposure scenario is to estimate an exposure case that is conservative, yet still within the range of possible exposures. Reasonable maximum is generally intended to characterize the 90th-95th percentile of the exposed population. Consideration of both average exposures and reasonable maximum exposures gives the risk manager a range of risk estimates to provide an indication of the variability, uncertainty, and inherent protectiveness in the assumptions used to quantify potential risks. Average exposures are sometimes referred to as "central tendency exposures". In this memorandum, the "average" and "central tendency"are used interchangeably.

Risk of Acute Effects

EPA's evaluation of the risk of acute effects from exposures to arsenic associated with soil pica behavior in children is considered to be a screening level evaluation because of the substantial uncertainty which exists in most of the exposure assumptions. The screening level calculations performed for the VB/I70 Site indicate:

- **Average soil pica exposures** may result in doses of arsenic that range from less than or equal to the reference dose (hazard quotient ≤ 1) to 100 times the reference dose (hazard quotient = 100). Between 294 and 1511 properties have arsenic concentrations that are predicted to result in an acute hazard quotient greater than 1 for average soil pica exposures.

- **Reasonable maximum soil pica exposures** may result in doses of arsenic that range from less than or equal to the reference dose (hazard quotient $\leq$ 1) to 300 times the reference dose (hazard quotient =300). Between 662 and 1841 properties have arsenic concentrations that are predicted to result in an acute hazard quotient greater than 1 for reasonable maximum soil pica exposures.

<u>Risk of Subchronic Non-Cancer Effects</u>

The baseline human health risk assessment indicates:

- At any residential property in VB/I70, children with **average levels of exposure** may incidentally ingest soil with arsenic and the resulting dose is predicted to be less than or equal to the subchronic reference dose (hazard quotient $\leq$ 1). There are no properties with arsenic concentrations that are predicted to result in a subchronic hazard quotient greater than 1 for average levels of exposure.

- Area children with **reasonable maximum levels of exposure** may incidentally ingest soil with arsenic that results in a dose ranging from less than or equal to the subchronic reference dose (hazard quotient $\leq$ 1) to 3 times the subchronic reference dose (hazard quotient = 3). There are 7 properties with arsenic concentrations that are predicted to result in a subchronic hazard quotient greater than 1 for reasonable maximum levels of exposure.

<u>Risk of Chronic Non-Cancer Effects</u>

The baseline human health risk assessment indicates:

- Area residents with **average levels of exposure** may, over a long period of time, incidentally ingest soil with arsenic and ingest garden vegetables with arsenic that results in a dose ranging from less than or equal to the chronic reference dose (hazard quotient $\leq$ 1) to 2 times the chronic reference dose (hazard quotient = 2). There are only 2 properties with arsenic concentrations that are predicted to result in a chronic hazard quotient greater than 1 for average levels of exposure.

- Area residents with **reasonable maximum levels of exposure** may, over a long period of time, incidentally ingest soil with arsenic and ingest garden vegetables with arsenic that results in a dose ranging from less than or equal to the chronic reference dose (hazard quotient $\leq$ 1) to 5 times the chronic reference dose (hazard quotient = 5). There are 26 properties with arsenic concentrations that are predicted to result in a chronic hazard quotient greater than 1 for reasonable maximum levels of exposure.

Cancer Risks

The baseline human health risk assessment indicates:

- Area residents with **average levels of exposure** may, over a long period of time, incidentally ingest soil with arsenic and ingest garden vegetables with arsenic that results in a cancer risk ranging from 2×10^{-6} to 9×10^{-5} . There are no properties where cancer risks are predicted to exceed 1×10^{-4} for average levels of exposure.

- Area residents with **reasonable maximum levels of exposure** may, over a long period of time, incidentally ingest soil with arsenic and ingest garden vegetables with arsenic that results in a cancer risk ranging from 1×10^{-5} to 8×10^{-4} . There are 99 properties where cancer risks are predicted to exceed 1×10^{-4} for reasonable maximum levels of exposure.

Table 1 summarizes the results of the baseline human health risk assessment.

Determination of Unacceptable Risks due to Arsenic Exposure

EPA guidance contained in the Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-30 (EPA, 1991) states that where the cumulative carcinogenic site risk to an individual based on the reasonable maximum exposure (RME) for both current and future land use is less than 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted . The guidance further states that EPA should clearly explain why remedial action is warranted if baseline risks are within the acceptable risk range of 10^{-6} to $10^{-4.}$ A risk manager may decide that a level of risk lower than 10^{-4} warrants remedial action where, for example, there are uncertainties in the risk assessment results.

Risks will be managed by applying EPA guidance in OSWER Directive 9355.0-30 to each individual residential yard in Operable Unit 1 of the VB/I-70 Site. This is because the exposure unit in the baseline human health risk assessment is the individual residential yard (or a sublocation of the yard) and baseline risks were calculated for each individual residential yard. EPA will make decisions about whether remedial action is necessary on a yard by yard basis.

Consistency with the EPA guidance in OSWER Directive 9355.0-30 is thus achieved at the VB/I70 Site by comparing the predicted carcinogenic and non-carcinogenic risks at each individual property to the guidelines described in the directive.

Table 1 reveals that there are between 662 and 1841 individual properties where the predicted RME hazard quotient exceeds 1 for potential acute effects associated with soil pica behavior. In accordance with EPA guidance, remedial action is warranted at these properties.

Table 1 also reveals that there are 99 individual properties where predicted RME cancer risks exceed 10^{-4}. In accordance with EPA guidance, remedial action is warranted at these 99 properties. Of these 99 properties, there are 26 properties where the predicted RME hazard quotient exceeds 1 for chronic non-cancer effects, and 7 properties where the predicted RME hazard quotient exceeds 1 for both subchronic and chronic non-cancer effects.

Remedial action at the 99 properties which addresses unacceptable predicted RME cancer risks will also address unacceptable predicted RME non-cancer risks of subchronic and chronic effects but will NOT address unacceptable RME risks of acute effects.

Consideration of Uncertainties in the Baseline Human Health Risk Assessment for Arsenic

Uncertainties in the Estimates of Cancer Risk

OSWER Directive 9355.0-30 states that consideration of uncertainties in the baseline risk assessment may lead a risk manager to decide that risks lower than 10^{-4} are unacceptable, triggering the need for remedial action. EPA considered the uncertainty in the arsenic risk calculations for VB/I70 to determine whether remedial action is needed at properties where risks are predicted to be less than or equal to 10^{-4}.

EPA undertook several studies to increase the accuracy (reduce uncertainty) of the risk estimates for the VB/I70 Site. The first was a study to investigate the relative bioavailability of arsenic in the soil found in the VB/I70 Site (EPA, 2001c). In the absence of site specific information on relative bioavailability, it is common practice to use a default assumption as the value for this parameter or to ignore relative bioavailability altogether in risk estimates. Measurements based on site specific soils significantly reduce the uncertainty in estimates of this parameter. In the study on VB/I70 Site soils, relative bioavailability was measured in five different soils collected from residential yards in the Site. Variability in the relative bioavailability of arsenic was observed between the five different site soils. EPA used a conservative estimate of the mean of the five values in the baseline risk assessment. This approach is expected to overestimate the true value of this parameter for any given soil in the residential yards in the Site. Thus the accuracy of the risk estimate was increased by using a VB/I70 Site-specific value and protectiveness was achieved by using a conservative estimate of the mean of all values measured at the Site.

The second study (EPA, 2001b) was an investigation into the VB/I70 Site-specific relationships between:

- arsenic in yard soil and arsenic in house dust;
- arsenic in yard soil and arsenic in garden soils;
- arsenic in garden soils and arsenic in garden vegetables.

Establishing these Site-specific relationships reduces the uncertainty in quantifying exposure and risk associated with incidental ingestion of soil and dust and ingestion of garden vegetables.

When risks are described as point estimates, it is difficult to evaluate the level of protectiveness inherent in the exposure assumptions used to calculate the risks. A point estimate of risk also does not provide any information about the uncertainties in the risk assessment. Uncertainty can be analyzed to some degree by comparing the central tendency point estimates and the RME point estimates. Large differences between the RME risk estimate and the central tendency risk estimate may indicate either a large amount of uncertainty in the estimates or a large amount of variability in the exposure parameters within the exposed population. At the VB/I70 site, the risk estimates indicate that cancer risks are within an acceptable range at properties if average or central tendency exposures are considered. Cancer risks are unacceptable at 99 properties if RME exposures are considered.

Another way to analyze uncertainty in risk estimates is by using Monte Carlo modeling, a computer based mathematical technique in which exposure parameters are characterized as probability density functions (PDF) rather than as point estimates. The premise of Monte Carlo modeling is that every assumption about exposure (e.g., the frequency of contact, soil ingestion rate) is a variable and can be modeled as a PDF. The PDF reflects a range of values with associated probabilities. In a Monte Carlo analysis, a risk calculation is repeated thousands of times using statistical techniques to select exposure values from the PDFs that characterize them. The thousands of combinations of exposure assumptions results in a range of risk estimates expressed as a distribution of risks that may exist at the site for the population being considered.

In theory, a Monte Carlo analysis can be performed for every property within the VB/I70 site. To simplify the analysis, EPA performed screening level Monte Carlo modeling of exposure and risk associated with a selected concentration of arsenic in soil at the VB/I70 Site. The results, which are included in the final Human Health Baseline Risk Assessment, indicate that the point estimate of risk for the RME scenario is located at the 99th percentile of the risk distribution. This means that it is highly unlikely that the chronic arsenic exposures EPA has characterized for the VB/I70 site are actually occurring in the people who reside there. The 99th percentile indicates that there is only a 1% chance that the RME chronic exposure is actually occurring at the Site and that only 1% of the population experience the RME exposure. These results indicate that the combination of exposure assumptions used by EPA for the chronic arsenic exposure assessment at this site may be at the upper bound of or even beyond the reasonable maximum exposure scenario.

The Monte Carlo analysis also showed that at properties where point estimate of risk is 1×10^{-4}, risks in the 90th percentile - 95th percentile range (the RME range) are 2×10^{-5} to 7×10^{-5}.

The uncertainty analysis indicates that actual risks are much more likely to be lower than the calculated point estimates of risks. Providing protection at the 1×10^{-4} risk level based on the point estimates of risk is likely to provide a level of protectiveness for the RME scenario in the range of 2×10^{-5} to 7×10^{-5}. Therefore, in accordance with EPA guidance in OSWER Directive 9355.0-30, based on EPA's consideration of the uncertainties in the cancer risk assessment for arsenic, remedial action is not warranted at those properties in VB/I70 where the point estimates of risk are less than or equal to 10^{-4}.

Uncertainties in the Estimates of Acute Risks

EPA also considered the uncertainty in the calculation of the risk of acute effects from exposures to arsenic associated with soil pica behavior in children. Two important facts were considered: (1) the distribution of soil ingestion rates for children with soil pica behavior is not known and (2) the frequency with which such children exhibit the behavior is also not known. Therefore, the application of Monte Carlo techniques to analyze the uncertainty in the calculations of acute risk is difficult and was not performed by EPA for the VB/I70 Site.

However, EPA characterized the theoretical average and RME point estimates of acute risk in screening level calculations. These estimates suggest that there are between 294 and 1511 individual properties with soil arsenic concentrations that are predicted to result in acute hazard quotient greater than 1 for the average soil pica scenario. There are between 662 and 1841 individual properties with soil arsenic concentrations that are predicted to result in acute hazard quotient greater than 1 for the RME soil pica scenario. The wide range of potentially affected properties, 294-1841, reflects the substantial uncertainty in quantifying these risks.

EPA guidance contained in OSWER Directive 9355.0-30 states that where the non-carcinogenic hazard quotient for an individual based on the reasonable maximum exposure for both current and future land use is less than 1, action generally is not warranted. EPA considered the range of 662 -1841 properties where application of this guidance indicates remedial action is warranted. This range is referred to as Case 1 (1841 properties) and Case 2 (662 properties) in the Baseline Human Health Risk Assessment. EPA also considered the following:

- EPA is not aware of any reported cases of acute arsenic toxicity attributable to ingestion of arsenic in soil.
- Limited data on urinary arsenic levels in residents of the VB/I70 area and the nearby Globeville neighborhood do not reveal the occurrence of high soil intakes by children.
- Inquiries by the Colorado Department of Public Health and Environment (CDPHE) into reports of known or suspected cases of arsenic poisoning in the community surrounding the VB/I70 site resulted in their conclusion, stated in a July 25, 2001 letter, that "....it appears that there is no obvious or identifiable

problem of arsenic exposure from environmental sources in the area of concern." (CDPHE, 2001).

These considerations suggest that arsenic risk from soil pica behavior may not be as significant as the theoretical calculations suggest. However, because of the high uncertainty regarding the magnitude and frequency of soil pica behavior, more reliable risk estimates for this scenario will not be possible until better data are collected on soil intake rates characteristic of soil pica behavior along with direct measurements of soil related exposures to arsenic.

Because of the substantial uncertainty in the risk calculations, the lack of evidence of soil pica behavior, the further lack of evidence that such behavior actually results in exposure to arsenic, and the lack of obvious or identifiable problem of arsenic exposure in VB/I70, EPA has determined that remediation is warranted at the minimum number of properties, 662, to address the risk of acute effects from theoretical exposures to arsenic associated with soil pica behavior in children who reside in the VB/I70 site. The Case 2 soil pica exposure scenario is considered the more appropriate scenario on which to base risk management decisions for risks associated with soil pica behavior. Remedial action is warranted at properties where the acute hazard quotient exceeds 1 for the Case 2 exposure scenario.

Development of Preliminary Action Levels for Arsenic in Residential Soils at VB/I70

Preliminary action levels are exposure point concentrations (EPCs) above which some remedial action is warranted. At the VB/I70 Site Operable Unit 1, the arsenic EPC is a conservative estimate of the mean concentration within an individual yard. An EPC for arsenic was calculated for each individual yard as part of the Baseline Human Health Baseline Risk Assessment. Properties where remedial action is warranted will be identified by comparing the EPCs to the preliminary action levels. Consistent with OSWER Directive 9355.0-30, preliminary action levels for arsenic in residential soils at VB/I70 are:

- An EPC of 47 milligrams per Kilogram (mg/Kg) which is the level of arsenic in soil associated with an acute hazard quotient which exceeds 1 for the Case 2 RME soil pica scenario.

- An EPC of 240 mg/Kg which is the level of arsenic in soil associated with an RME cancer risk which exceeds 1×10^{-4} as a point estimate, 2×10^{-5} as the 90^{th} percentile of the risk distribution, and 7×10^{-5} as the 95^{th} percentile of the risk distribution.

Human Health Risks Associated with Potential Exposure to Lead

EPA's quantitative baseline human health risk assessment for the VB/I70 Site Operable Unit 1 also considered the health risks associated with exposure of residents to concentrations of lead measured in soil collected from their yards. The population of most concern for exposure to lead in soil is young children. EPA evaluates risks associated with exposure to lead by considering total exposure via all sources and pathways in the environment rather than to site related exposures only. This requires assumptions about the level of lead in food, air, water, and paint as well as the level of lead measured in yard soils.

The adverse health effect associated with lead exposure that was considered by EPA is lead-induced neurobehavioral effects in children. EPA's OSWER determined that, in Superfund Site cleanups, EPA will attempt to limit exposure to soil lead levels such that a typical (or hypothetical) child or group of similarly exposed children would have an estimated risk of no more than 5% of exceeding a blood lead level of 10 micrograms per deciliter (ug/dL) (EPA 1994). EPA has identified this blood lead level as the level at which health effects which warrant avoidance in children begin to occur.

The baseline human health risk assessment indicates that there is a greater than 5% chance that a child will have a blood level of 10 ug/dL as a result of exposure to lead in soil at 1331 properties. This prediction of lead risk was determined by using EPA's Integrated Exposure/Uptake Biokinetic (IEUBK) Model. In order to increase the accuracy of the model results, EPA used VB/I70 Site-specific data on the relationship between lead in the fine and bulk fractions of soil, the relationship between lead in yard soil and lead in house dust (EPA, 2001b), and the relative bioavailability of lead in soils (EPA, 2001d).

Consideration of Uncertainties in the Baseline Human Health Risk Assessment for Lead

In order to investigate some of the sources of uncertainty in the IEUBK model predictions for the VB/I70 Site, EPA ran the model a number of times, varying the values for dietary lead intake, geometric standard deviation of blood lead levels, and soil intake rate to reflect recently published data. The results of the alternative model runs are presented in the final Baseline Human Health Risk Assessment document.

The range of results indicate that there is a greater than 5% chance that a child will have a blood level of 10 ug/dL as a result of exposure to lead in soil at between 2 and 1331 properties. This wide range indicates substantial uncertainty in predictions of blood lead levels using the IEUBK model at the VB/I70 site.

EPA also predicted blood lead levels in children in VB/I70 using a different model than the IEUBK. The results of this modeling effort, also presented in the final Baseline Human Health Risk Assessment, indicate that there are no properties where lead levels in soil are predicted to result in a greater than 5% chance that a child will have a blood level of 10 ug/dL, suggesting that remedial action to address lead in soil may not be warranted.

Consideration of Observed Blood Lead Values in Children Who Reside in VB/I70

EPA reviewed the available information on measured blood lead levels in the population of children in VB/I70 to better understand how well the IEUBK model was predicting blood lead levels at the Site. The CDPHE offered three separate blood lead testing programs to children living in the VB/I70 site during the period 1995 through 2000 and provided the results of this testing to EPA. Although the blood lead testing was not designed or intended to support risk assessment, the data support the following conclusions:

- elevated blood lead levels do occur in children residing within the site
- soil is not likely to be the main source of elevated blood lead levels in children
- the elevated blood lead levels that were observed in children within VB/I70 are not clearly different from the elevated levels observed in children who live outside of VB/I70

Development of Preliminary Action Levels for Lead in Residential Soils at VB/I70

Each alternative IEUBK model run predicts that EPA's health goal for lead in soil will be met at a specific average soil lead concentration or lead EPC in an individual yard. The alternative model runs performed by EPA resulted in a range of such EPCs. These are average lead concentrations in a yard above which remedial action may be warranted to achieve EPA's health goal and are referred to as preliminary action levels. The range of soil lead concentrations is presented in Table 2.

EPA considered the following factors in developing the preliminary action levels for lead from the range provided in Table 2 that will be used in the feasibility study for the VB/I70 Site:

- Available blood lead data indicates that soil is not likely to be the main source of elevated blood lead levels in children in VB/I70.
- Predictions using an alternative model suggest that remedial action of soil may not be required to achieve EPA's health goal for lead in soil.

These factors led EPA to develop two preliminary action levels for lead in soil at VB/I70:

(1) 208 mg/Kg as the yard EPC. This is the soil concentration at the lowest end of the range of soil concentrations that the IEUBK model predicts EPA's health goal will be exceeded; and

(2) 540 mg/Kg as the yard EPC. This is the soil concentration at the higher end of the range of soil concentrations that the IEUBK model predicts EPA's health goal will be exceeded.

Remedial action is warranted at any individual yard where the lead EPC exceeds either of these preliminary action levels. Based on the indications from the available blood lead data and the uncertainty that remedial action is warranted at all to address lead risks, EPA considers 540 mg/Kg as the preliminary action level for engineering actions. This recognizes that soil is not likely to be main source of elevated blood lead levels.

References:

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EPA. 2001a. Baseline Human Health Risk Assessment Vasquez Boulevard and I-70 Superfund Site Denver, CO. U. S. Environmental Protection Agency, Region 8 with technical assistance from Syracuse Research Corporation. August, 2001.

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EPA, 2001c. Relative Bioavailability of Arsenic in Soils from the VBI70 Site. Report prepared for EPA Region VIII by Syracuse Research Corporation. January 2001.

EPA, 2001d. Relative Bioavailability of Lead in Soils from the VBI70 Site. Report prepared for EPA Region VIII by Syracuse Research Corporation. February 2001.

Table 1 Summary of Baseline Human Health Risk Assessment for Arsenic VB/I-70 Residential Soils				
Health Effect	**Average or Central Tendency Exposure**		**Reasonable Maximum Exposure**	
	Range of Calculated Risks	**# properties where risks are predicted to be unacceptable**	**Range of Calculated Risks**	**# properties where risks are predicted to be unacceptable**
acute non-cancer effects	$.07 \leq HQ^{1} \leq 100$	294-1511	$0.2 \leq HQ \leq 300$	662- 1841
subchronic non-cancer effects	$.003 \leq HQ \leq 0.8$	0	$0.01 \leq HQ \leq 3$	7
chronic non-cancer effects	$.04 \leq HQ \leq 2$	2	$0.1 \leq HQ \leq 5$	26
cancer effects	$2 \times 10^{-6} \leq$ Cancer Risk $\leq 9 \times 10^{-5}$	0	$1 \times 10^{-5} \leq$ Cancer Risk $\leq 8 \times 10^{-4}$	99

1. HQ = hazard quotient, defined as ratio of predicted site dose to reference dose

Table 2 Alternative Preliminary Action Levels for Lead in Soil VB/I70 Site			
IEUBK Model Run	**Dietary Lead Intake Values**	**Geometric Standard Deviation of Blood Lead Values**	**Predicted Lead Soil Level at P10 < 5%[1] (mg/Kg)**
1	default	1.6 (default)	208
2	revised	1.6 (default)	246
3	default	1.4	326
4	revised	1.4	362
5	revised	1.3	443
6	default	1.2	542
7	revised	1.2	581

1. P10 < 5% = less than 5% probability that blood lead levels exceed 10 ug/dL

APPENDIX D

CDPHE COMMENTS ON THE DRAFT FS REPORT AND EPA RESPONSES

EPA RESPONSES TO STATE OF COLORADO COMMENTS ON THE DRAFT FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 1 VASQUEZ BOULEVARD/I-70 SUPERFUND SITE, DENVER, COLORADO

The following provides the comments from CDPHE on the draft FS report in italicized text followed by EPA's response. Single comments that covered a range of issues have been split up as necessary to provide a clear response. The original letter from CDPHE is also attached.

GENERAL COMMENTS

Remedial Action Objectives (RAOs) for arsenic in soil

RAO "A" establishes a cleanup objective to prevent additional lifetime cancer risk due to ingestion of arsenic in soil and home-grown vegetables that is greater than a 1 X 10^{-4} risk level. Based on the exposure and toxicity evaluation methodology discussed in the Human Health Risk Assessment, this corresponds to an arsenic soil concentration of 240 ppm. While there are many conservative assumptions made in the derivation of this risk-based cleanup level, CDPHE is not comfortable selecting a value at the high end of the acceptable risk range. As an alternative, we propose selecting a risk value that will provide a cleanup objective at least as protective as that provided in Globeville residents by the state, within a risk range of 3 x 10^{-5} to 8 x 10^{-5}. Based on information specific to the VBI70 site and information presented in the feasibility study, this corresponds to an arsenic soil concentration between 42 ppm and 128 ppm. The state believes that increasing the level of protectiveness will help address uncertainty about the impact of site-specific socio-demographic factors. Since there are no technical reasons why a lower cleanup level could not be chosen, and since the local community would support a lower cleanup level, the state believes all impacted neighborhoods in the North Denver areas should receive equal protection, and therefore choosing a more protective action level for chronic arsenic exposure is appropriate.

The Remedial Action Objective to prevent additional lifetime cancer risk due to ingestion of arsenic in soil and homegrown vegetables was established based on the findings of the baseline human health risk assessment and is consistent with EPA guidance in the OSWER Directive 9355.0-30, "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions". The guidance states that EPA should clearly explain why remedial action is warranted if baseline risks are within the acceptable risk range of 10^{-6} to $10^{-4.}$ A risk manager may decide that a level of risk lower than 10^{4} warrants remedial action (as suggested by the State for VB/I70) where, for example, there are uncertainties in the risk assessment results. EPA considered the uncertainty in the risk estimates when developing the Remedial Action Objectives and a summary is provided as an appendix to the final Feasibility Study. The main points specific to arsenic in soils are:

A. As part of the Remedial Investigation for the VB/I70 Site, EPA undertook several studies specifically to increase the accuracy (reduce uncertainty) of the risk estimates. The first was a study to investigate the relative bioavailability of arsenic in the soil found in the VB/I70 Site. The second was the Phase 3 Investigation in which data were collected to establish VB/I70 Site-specific relationships between:

I. Arsenic in yard soil and arsenic in house dust;
II. Arsenic in yard soil and arsenic in garden soils; and
III. Arsenic in garden soils and arsenic in garden vegetables.

B. EPA performed Monte Carlo modeling as part of the uncertainty analysis in the Baseline Human Health Risk Assessment. The results indicate that the point estimate of risk for the Reasonable Maximum Exposure (RME) scenario is located at the 99^{th} percentile of the risk distribution. This means that it is highly unlikely that the chronic arsenic exposures EPA has characterized for the VB/I70 site are actually occurring in the people who reside there. The 99^{th} percentile indicates that there is only a 1% chance that the RME chronic exposure is actually occurring at the site and that only 1% of the population experience the RME exposure. These results indicate that the combination of exposure assumptions used by EPA for the chronic arsenic exposure assessment at this site may be at the upper bound of or even beyond the reasonable maximum exposure scenario. The Monte Carlo analysis also showed that at properties where point estimate of risk is 1×10^{-4}, risks in the 90^{th} percentile - 95^{th} percentile range (the RME range) are 2×10^{-5} to 7×10^{-5}.

The uncertainty analysis indicates that actual risks are much more likely to be lower than the calculated point estimates of risks. Providing protection at the 1×10^{-4} risk level based on the point estimates of risk is likely to provide a level of protectiveness for the RME scenario in the range of 2×10^{-5} to 7×10^{-5}. Therefore, in accordance with EPA guidance in OSWER Directive 9355.0-30, based on EPA's consideration of the uncertainties in the cancer risk assessment for arsenic, remedial action is not warranted at those properties in VB/I70 where the point estimates of risk are less than or equal to 10^{-4}.

The State identifies four reasons for proposing that EPA establish a remedial action objective for arsenic in soil within a risk range of 3×10^{-5} to 8×10^{-5} as a point estimate. EPA considered the State's concerns and provides the following responses:

1. EPA is not aware of any site-specific socio-demographic factors that have not already been accounted for in the baseline risk assessment. Since 1998, EPA worked with the VB/I70 Working Group and held public meetings during the development of the risk assessment specifically to identify site specific behaviors and practices which may affect exposures to arsenic in soil at the site. The factors which have been incorporated into the exposure assessment include residents who have lived for a long time at the same address, the proportion of residents with vegetable gardens, and the practice of being away from home for significant periods while visiting relatives in other countries. EPA is not aware of any other socio-demographic factors which would affect exposure.

2. While EPA agrees that there are no technical reasons why a lower cleanup level could not be chosen, OSWER Directive 9355.0-30 specifies that the decision to take action should be based on considerations of protection of public health and establishing justification that there is an imminent and substantial endangerment.

3. There is no information in the administrative record to support the State's claim that the local VB/I70 community would support a lower cleanup level. The local community includes residents at 4000 individual properties, the vast majority of which have not been informed that a feasibility study is underway. The Proposed Plan has not yet been prepared and distributed and no public comment period has yet been provided by EPA. It would be inconsistent with the National Contingency Plan to consider community acceptance as part of the feasibility study process and before a public comment period is provided.

4. The State believes that all impacted neighborhoods in the North Denver areas should receive equal protection and proposes that EPA "select a risk value that will provide a cleanup objective at least as protective as that provided in Globeville residents by the state". EPA believes there is less uncertainty in the risk assessment for VB/I70 than in the assessment which supports the risk management decisions made by the State in Globeville. Uncertainty was reduced at VB/I70 by collecting site specific data on key exposure parameters and relative bioavailability of arsenic in soils, and by developing a statistically based soil sampling program. The differences in the uncertainty and the likelihood that the contaminant sources for the two sites are different make a direct comparison the two risk assessments problematic.

However, to address the State's concerns, an additional remedial alternative has been added to the final Feasibility Study. This alternative requires removal and replacement of soils at properties where the arsenic exposure point concentration is above 128 mg/Kg. The arsenic soil concentration at the lower end of the range proposed by the State, an arsenic concentration of 42 mg/Kg, is sufficiently close to the preliminary action level of 47 mg/Kg already included in the Feasibility Study that EPA believes there is no need to develop yet another alternative. All alternatives are evaluated against the criteria specified in the National Contingency Plan. The final Feasibility Study thus provides sufficient information to allow EPA to consider the risk range proposed by the State in EPA's final cleanup decision.

In addition, as you are aware, the Colorado Central Cancer Registry (CCCR) has compiled cancer statistics for the VBI70 area in response to a request by local community members. The Disease Control and Environmental Epidemiology Division (DCEED) is currently conducting an internal review of these data and will provide a report back to community members at the end of September. We anticipate further consideration by our Division managers of the RAO level for arsenic after the cancer study is complete.

The comment is noted.

Alternatives 2 and 3 in the FS incorporate a community health program (CHP) intended to address any residual risks which may be occurring in the community, recognizing the high level of uncertainty in the efficacy of selecting additional soil cleanup in response to uncertain risks associated with pica exposure or to address the potential risk for elevated blood lead levels identified by the IEUBK model. EPA should provide information about similar community-based programs that document the effectiveness of addressing residual risk in this manner.

Available information about similar community-based programs is presented in Appendix A.

The program should be described in as much detail as possible, including the future responsibilities of the agencies involved, and the costs associated with these responsibilities. The current cost estimates for administering such a comprehensive community health program appear to be very low. This type of thorough evaluation is required in the feasibility study in order to properly evaluate alternatives against the nine criteria. In particular, issues regarding implementability and long-term effectiveness need to be addressed.

The community health program has been described in detail in the report, including the structure of the program, the elements of the programs for lead and arsenic, and the targeted populations. The costs associated with the program have been increased based on discussions at the FS briefing meeting. If an alternative containing the program is selected by EPA, it will have the overall responsibility for implementing the program. EPA may choose to enter into agreements with other organizations or agencies to implement certain components of the programs. In this event, EPA will provide funds for implementation.

If a community health program is to be implemented as part of the remedy, we believe that the arsenic component of the program needs to be more thorough and pro-active and must adequately demonstrate that exposure and residual risk are not occurring at an unacceptably high level.

As described in the FS, chronic cancer and non-cancer risks from incidental ingestion of soil containing arsenic will be addressed by soil removal. A component of all action alternatives is a program to sample properties that have not been adequately characterized and to implement soil removal if the arsenic exposure point concentration is above the action level. Therefore, the community health program for arsenic would focus specifically on the potential risks to young children from soil pica behavior. The program would be aggressively implemented, as described in the final FS, concomitant with the blood lead program. Specific details of the implementation and data interpretation would be developed in remedial design, expected to occur later this year.

Remedial Action Objectives (RAOs) for lead in soil

The FS should fully document the basis of the action level of 600 ppm for lead in soil and the rationale for selecting that particular action level.

The final FS contains this documentation of the action level (modified to 540 ppm) in Appendix C.

The document needs to clarify which properties would be eligible for paint testing and potential remediation. On page ES-8 (see paragraph prior to Alternative 3 discussion), it is stated that paint will be addressed if lead in soil is an exposure pathway, but "if soils are not an issue" residents will be given information and referred to other local programs. It is not clear whether lead in soil is considered to be a problem if it exceeds the IEUBK default level (208 ppm) or if it exceeds the target action level (600 ppm). (Similar language occurs on page 49, "Response Program").

As noted in the document, it is envisioned that a sampling investigation at a particular residence for lead would be triggered by the results of blood-lead monitoring of a child living at that property. The investigation would be comprehensive and would seek to assess not only soil-related exposures, but exposures from other (non-soil) sources as well (paint, water, cookware, other lead-containing items, etc.). In the event that soil sampling is performed (for example, if the property was not previously sampled) and finds that the lead exposure point concentration in yard soils is above the action level (600 ppm in the draft FS; revised to 540 ppm in the final document and will be established in the Record of Decision), soil will be remediated in accordance with the requirements set out in the Record of Decision regardless of other potential sources. If the lead exposure point concentration is below the action level, but soil is judged to be the most likely source of exposure, a series of actions will be evaluated on a property-specific basis to identify the most effective way to reduce that exposure. These will include a wide range of potential alternatives, including such things as education, sodding or capping of contaminated soil, removal, tilling/treatment, etc. In the event that soil is judged to be the most likely source of exposure and exterior paint is a source of lead contamination in soil, remediation of the paint may be considered in conjunction with remediation of the soil. If the main source of exposure is judged to be non-soil related, responses may include things such as education and counseling, or referral to environmental sampling/response programs offered by other agencies, as appropriate based on the property-specific situation.

The document contains inconsistencies about specific components of the proposed biomonitoring program. For example, on page 48, testing for arsenic in urine and hair is proposed, whereas other *discussions about arsenic biomonitoring,mention only urine arsenic testing. Also, cost estimates shown in Appendix B do not appear to be consistent with offering the three types of testing shown on page 48 (i.e., blood lead testing in children and urine and hair arsenic testing for all residents).*

The final FS has been revised to include urine testing only for arsenic. This type of monitoring would be most appropriate for detection of short-term exposures potentially associated with soil pica behavior. The cost estimates in Appendix B contain items for blood lead and urine arsenic monitoring.

SPECIFIC COMMENTS

ES-3, second bullet from the bottom

The document needs to clarify whether ***all*** *properties which exceed a HI of one for sub-chronic and chronic non-cancer risks also exceed the target cancer risk of 1×10^{-4}. This bullet states that these properties are "****mainly*** *at the same locations". Also, see similar language on page 11, first paragraph.*

The document has been modified to state that non-cancer risks from chronic or sub-chronic RME exposures to arsenic are also above a level of human health concern at some properties, but all of these properties are also predicted to have RME cancer risks above 1E-04.

ES-7

As requested at the FS briefing meeting, please revise the description of the Group 3 properties, currently defined as properties where "risks are probably not of significant concern". (Similar language occurs on page 46).

The description of the community health program has been modified per discussions at the FS briefing meeting. The group categories are no longer used.

Section 5.2, Alternative 2. Community Health Program

While CDPHE agrees that a Community Health Program would be beneficial, we have several concerns. EPA must provide a much greater level of detail about the program such as which agencies will be expected to implement which components and how EPA will assure adequate funding of those programs over 30 years. Issues regarding implementability and long-term effectiveness need to be addressed. Do agencies have the resources and expertise to manage the program? Can we expect sufficient participation? In addition, there needs to be a specific goal, and a specific end point when the program reaches that goal.

If an alternative that includes a community health program is chosen by EPA as the remedial action for the Site, the community health program, like all other components of the action, will be funded by Superfund with the standard cost share amount provided by the State. Because it would be part of remedial action, a community health program is equally certain to be funded as any other component of the action, including the engineering components.

Goals for the program will be based on the RAOs; statistical approaches to data evaluation and program evaluation (including the endpoint) will be specified in a remedial design report (with review and input from CDPHE and the community), if this alternative is selected by EPA. Remedial design is expected to occur later this year.

Section 5.2, subsection 2. Biomonitoring Program – Page 47, component number 2

Point 2 of the Community Health Program addresses the biomonitoring program being proposed as part of the CHP alternative and states that the purpose of the biomonitoring is to determine "if excessive exposure to lead or arsenic is occurring". General comment #1 recommends broadening the focus of the arsenic biomonitoring component of the CHP to meet the stated objective of determining whether atypical exposure is occurring in this community.

Please see the response to general comment #1. It is not clear what CDPHE means by "atypical" exposure and EPA is not aware of any stated objective described in the last sentence of the comment. Exposures representing a health risk identified by the biomonitoring component of the community health program would be addressed by the remedial action as discussed in the FS report.

Section 5.2, subsection 2. Biomonitoring Program – Page 48

The description in the second paragraph of the active recruitment program to be implemented needs to be redefined to clearly state who is eligible for the program, who is encouraged to participate in the program, and a justification as to why. While it appears that all persons are eligible, the RAO's are directed toward preventing exposure to children less than 72 months in age. While we agree that children, in particular those less than 72 months old, are a sensitive population for lead exposure, the outreach described may overlook residents who are at risk for exposure to arsenic.

The FS report has been modified to provide a clearer description of the community health program. Children less than 72 months are eligible for the biomonitoring program, which would be part of the overall program to assess and address any residual risks associated with lead exposure in soils and arsenic exposure in soils due to soil pica behavior. Long-term chronic and sub-chronic risks due to incidental ingestion of soil with arsenic would be addressed by soil removal. As noted previously, each action alternative contains an on-going program to sample all properties that have yet to be characterized. Remediation will be performed at all properties with lead or arsenic exposure point concentrations greater than action levels established in the Record of Decision.

Section 5.2, subsection 2 and 3. Education and Outreach Program, Biomonitoring Program and Soil Sampling Program

These programs are defined as operating "... as long as the remedy operates." Please clarify how long the remedy will operate and what measurement criteria will be used to determine the effectiveness of the remedy. Without a clear method for determining the duration of the remedy, the Community Health Program, and subsequent response actions, it is impossible to accurately estimate O&M costs.

The effectiveness of the community health program would be measured against the requirements of the remedial action objectives. Statistical methods for data evaluation and interpretation would be established in remedial design, with review and input from CDPHE, other interested agencies, and the community. It is anticipated that design will occur later this year. For the purposes of the FS evaluation, it was assumed that the program would operate for 30 years. While a shorter or longer program may actually be implemented, EPA does not believe that this affects the findings of the FS analysis or EPA's ability to select a remedy for the site. As described in the final FS report, there are no O&M costs associated with any of the remedial alternatives; all costs are associated with remedial action or with 5-year review costs.

Section 5.2, Subsection 3. Soil Sampling Program

The Community Health Program should include an effort to identify and sample all licensed and non-licensed childcare situations. This should include all forms of in-home childcare.

An effort was made to sample all licensed childcare situations in the Phase III Field Investigation. In the FS each action alternative includes a program to sample all properties that have not been previously characterized.

Section 5.2, subsection 4. Response Program

CDPHE agrees that biomonitoring information that indicates exposure to a resident should result in a response action, however, it seems that the cost of performing removals if indicated would be significantly higher than including them in a one-time removal action. It is unclear how EPA will perform subsequent removals.

EPA has performed soil removals at the VB/I70 site in the past and expects to perform them in the future, both during initial remedial action and afterwards, if the community health program is selected as part of the remedy. Technical resources and funding will be available to perform individual removals as part of the on-going remedial action in the future. As described in the FS report, costs for soil removal/replacement performed during a larger initial phase remedial action effort (i.e., components of Alternatives 2 through 5) would be lower per yard than for individual removals performed in the future under the community health program. The evaluation of these approaches is contained in the comparison of Alternatives 3 and 5.

Further, we are concerned that biomonitoring information is subject to the success or failure of implementation of component 1 and 2 of the Community Health Program. As pointed out in our comment on Section 5.2, subsection 2, participation in the biomonitoring program may favor residents with children and thus overlook certain portions of the community. Residents without children may have higher levels of arsenic and lead in their soils yet not participate in the biomonitoring program and therefore not benefit from the Response Program component of the Community Health Program. If such a property is subsequently sold to a family with children, it is unclear whether the Community Health Program will provide testing to future residents.

Based on the findings of the Baseline Human Health Risk Assessment, it is noted that all identified human health risks related to lead are associated with incidental soil exposure to children between the ages of 6 and 72 months. Management of unacceptable risks to children related to lead in soil will provide protection to adult residents.

Each remedial action alternative contains a program to sample all properties that have not yet been characterized, regardless of whether children are present. Under Alternatives 2 through 4 this will be publicized through the ongoing community outreach program and will therefore be available to any resident at an unsampled property at any time. Under this program, if lead or arsenic concentrations exceed action levels, remediation will be performed at the property, in accordance with the requirements of the Record of Decision.

If a property with arsenic or lead levels below established action levels for engineering responses (and thus not requiring soil remediation) is sold to a family with children, those children will be eligible to participate in the biomonitoring program and all other aspects of the Community Health Program will be available to the owners for as long as the program operates. The predicted unacceptable health risks such children may face are limited to exposures associated with soil pica behavior (which are thought to be rare) and exposures to non-soil sources of lead. EPA will run the community health program until remedial action objectives are met. EPA anticipates this will require many years, probably at least 10 years and we are planning 30. During that time, EPA will be collecting data on actual exposures. If, in reviewing the data, EPA decides that engineering actions to address lead or arsenic in soil are appropriate at a lower level than the action level, EPA can and will adjust the action level as appropriate. It is extremely unlikely that any child who currently lives in VB/I70 or who may live there in the future will be left with unacceptable risks.

Section 5.4

The action level for lead is referred to a 208 mg/Kg. In Section 6.4, it is 207 mg/Kg. Please revise to refer to a consistent number throughout the document.

The value has been revised to 208 mg/kg throughout.

Tables B-1 and B-2

It does not seem possible that the annual operating and maintenance costs for a Community Health Program of the size and scope of that described in the document could be run for $185,491 annually.

The annual costs have been adjusted based on discussions of the likely scope of the Community Health Programs at the FS briefing meeting. The revised annual cost is approximately $330,000.

Further, the 30-year estimates for the Community Health Program do not factor a rate of inflation into the calculation. Present worth costs do not accurately estimate the true cost of such a program for thirty years out.

The cost estimates were prepared in accordance with OSWER Directive 9355.0-75 "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study". Per that guidance, the estimated costs for the alternatives are present value costs (i.e., the amount needed to be set aside at the initial point in time to assure that funds will be available in the future as they are needed). Consistent with the guidance, constant dollars, or "real dollars" are used for the present value analysis (i.e., no adjustment for inflation is made, because the present value reflects current costs of particular components regardless of when they are performed). As such, the dollar values shown in the present worth tables are not intended to identify the actual future costs of the Community Health Program and no changes were made to the document based on this comment.

Table B-7

The cost estimates presented in Appendix B of the document (Tables B-6 and B-7) for implementation of the plan appear low when considering the scope of services offered and the size of the affected community.

As discussed in the response to the previous comment on Tables B-1 and B-2, the scope and costs of the Community Health Program have been adjusted.

An estimate of 250 arsenic and lead tests represents a very low participation rate, which is not consistent with implementing "a very aggressive" biomonitoring program.

The final FS contains an estimate of 700 arsenic and lead tests per year.

Also the cost estimate does not appear to include costs for any paint testing or abatement.

The costs did include paint testing and abatement. Table B-8 has been modified to clarify these items.

Figure 5-1

The street names on the map are not legible. Please adjust the font size.

The size of the figure has been increased to provide a clearer presentation.

STATE OF COLORADO

Bill Owens, Governor
Jane E. Norton, Executive Director

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Colorado Department of Public Health and Environment

September 7, 2001

Ms. Bonita Lavelle
EPA Region 8
999 18th Street, Suite 500
Denver, CO 80202-2466

Re: Draft Feasibility Study Report for Operable Unit 1 Vasquez Boulevard/Interstate 70 Superfund Site Denver, Colorado (July 25, 2001)

Dear Ms. Lavelle:

The Colorado Department of Public Health and Environment (CDPHE) has received and reviewed the above-referenced document. During our review, we identified two general concerns. First, CDPHE believes that all impacted neighborhoods in the North Denver area should receive equal protection and therefore recommends that EPA revise its remedial action objective for arsenic in soils to a level that is as protective as that provided Globeville residents by the state. Second, while the state supports the concept of a community health program, the document does not provide an adequate level of detail for us to fully evaluate the program. We believe more detail needs to be included in the Final Feasibility Study and not left to the design phase of the project.

Our general and specific comments are attached. Please feel free to call me at 303-692-3395 if you have any questions about our comments.

Sincerely,

Barbara O'Grady

Barbara O'Grady
State Project Manager

Cc: Jane Mitchell, DCEED
Ginny Brannon, AGO
File: VAS 3.9

State of Colorado
Comments on the Draft Feasibility Study Report for Operable Unit 1
Vasquez Boulevard/I-70 Superfund Site,
Denver, Colorado

GENERAL COMMENTS

Remedial Action Objectives (RAOs) for arsenic in soil

RAO "A" establishes a cleanup objective to prevent additional lifetime cancer risk due to ingestion of arsenic in soil and home-grown vegetables that is greater than a 1×10^{-4} risk level. Based on the exposure and toxicity evaluation methodology discussed in the Human Health Risk Assessment, this corresponds to an arsenic soil concentration of 240 ppm. While there are many conservative assumptions made in the derivation of this risk-based cleanup level, CDPHE is not comfortable selecting a value at the high end of the acceptable risk range. As an alternative, we propose selecting a risk value that will provide a cleanup objective at least as protective as that provided to Globeville residents by the state, within a risk range of 3×10^{-5} to 8×10^{-5}. Based on information specific to the VBI70 site and information presented in the feasibility study, this corresponds to an arsenic soil concentration between 42 ppm and 128 ppm. The state believes that increasing the level of protectiveness will help address uncertainty about the impact of site-specific socio-demographic factors. Since there are no technical reasons why a lower cleanup level could not be chosen, and since the local community would support a lower cleanup level, the state believes all impacted neighborhoods in the North Denver areas should receive equal protection, and therefore choosing a more protective action level for chronic arsenic exposure is appropriate.

In addition, as you are aware, the Colorado Central Cancer Registry (CCCR) has compiled cancer statistics for the VBI70 area in response to a request by local community members. The Disease Control and Environmental Epidemiology Division (DCEED) is currently conducting an internal review of these data and will provide a report back to community members at the end of September. We anticipate further consideration by our Division managers of the RAO level for arsenic after the cancer study is complete.

Alternatives 2 and 3 in the FS incorporate a community health program (CHP) intended to address any residual risks which may be occurring in the community, recognizing the high level of uncertainty in the efficacy of selecting additional soil cleanup in response to uncertain risks associated with pica exposure or to address the potential risk for elevated blood lead levels identified by the IEUBK model. EPA should provide information about similar community-based programs that document the effectiveness of addressing residual risk in this manner. The program should be described in as much detail as possible, including the future responsibilities of the agencies involved, and the costs associated with these responsibilities. The current cost estimates for administering such a comprehensive community health program appear to be very low. This type of thorough evaluation is required in the feasibility study in order to properly evaluate alternatives against the nine criteria. In particular, issues regarding implementability and long-term effectiveness need to be addressed.

If a community health program is to be implemented as part of the remedy, we believe that the arsenic component of the program needs to be more thorough and pro-active and must adequately demonstrate that exposure and residual risk are not occurring at an unacceptably high level.

Remedial Action Objectives (RAOs) for lead in soil

The FS should fully document the basis of the action level of 600 ppm for lead in soil and the rationale for selecting that particular action level. The document needs to clarify which properties would be eligible for paint testing and potential remediation. On page ES-8 (see paragraph prior to Alternative 3 discussion), it is stated that paint will be addressed if lead in soil is an exposure pathway, but "if soils are not an issue" residents will be given information and referred to other local programs. It is not clear whether lead in soil is considered to be a problem if it exceeds the IEUBK default level (208 ppm) or if it exceeds the target action level (600 ppm). (Similar language occurs on page 49, "Response Program").

The document contains inconsistencies about specific components of the proposed biomonitoring program. For example, on page 48, testing for arsenic in urine and hair is proposed, whereas other discussions about arsenic biomonitoring mention only urine arsenic testing. Also, cost estimates shown in Appendix B don't appear to be consistent with offering the three types of testing shown on page 48 (i.e., blood lead testing in children and urine and hair arsenic testing for all residents).

SPECIFIC COMMENTS

ES-3, second bullet from the bottom

The document needs to clarify whether **all** properties which exceed a HI of one for sub-chronic and chronic non-cancer risks also exceed the target cancer risk of 1×10^{-4}. This bullet states that these properties are "**mainly** at the same locations". Also, see similar language on page 11, first paragraph.

ES-7

As requested at the FS briefing meeting, please revise the description of the Group 3 properties, currently defined as properties where "risks are probably not of significant concern". (Similar language occurs on page 46.)

Section 5.2 Alternative 2 - ...Community Health Program

While CDPHE agrees that a Community Health Program would be beneficial, we have several concerns. EPA must provide a much greater level of detail about the program such as which agencies will be expected to implement which components and how EPA will assure adequate funding of those programs over 30 years. Issues regarding implementability and long-term effectiveness need to be addressed. Do agencies have the resources and expertise to manage the program? Can we expect sufficient participation? In addition, there needs to be a specific goal, and a specific end point when the program reaches that goal.

<u>Section 5.2, subsection 2, Biomonitoring Program – Page 47</u><u>, component number 2</u>

Point 2 of the Community Health Program addresses the biomonitoring program being proposed as part of the CHP alternative and states that the purpose of the biomonitoring is to determine "if excessive exposure to lead or arsenic is occurring." General comment #1 recommends broadening the focus of the arsenic biomonitoring component of the CHP to meet the stated objective of determining whether atypical exposure is occurring in this community.

<u>Section 5.2, subsection 2, Biomonitoring Program – Page 48</u>

The description in the second paragraph of the active recruitment program to be implemented needs to be redefined to clearly state who is eligible for the program, who is encouraged to participate in the program, and a justification as to why. While it appears that all persons are eligible, the RAO's are directed toward preventing exposure to children less than 72 months in age. While we agree that children, in particular those less than 72 months old, are a sensitive population for lead exposure, the outreach described may overlook residents who are at risk for exposure to arsenic.

<u>Section 5.2, subsection 2 and 3, Education and Outreach Program, Biomonitoring Program and Soil Sampling Program</u>

These programs are defined as operating "...as long as the remedy operates." Please clarify how long the remedy will operate and what measurement criteria will be used to determine the effectiveness of the remedy. Without a clear method for determining the duration of the remedy, the Community Health Program, and subsequent response actions, it is impossible to accurately estimate O& M costs.

<u>Section 5.2, subsection 3, Soil Sampling Program</u>

The Community Health Program should include an effort to identify and sample all licensed and non-licensed childcare situations. This should include all forms of in-home childcare.

<u>Section 5.2, subsection 4, Response Program</u>

CDPHE agrees that biomonitoring information that indicates exposure to a resident should result in a response action, however, it seems that the cost of performing removals if indicated would be significantly higher than including them in a one-time removal action. It is unclear how EPA will perform subsequent removals. Further, we are concerned that biomonitoring information is subject to the success or failure of implementation of component 1 and 2 of the Community Health Program. As pointed out in our comment on Section 5.2, subsection 2, participation in the biomonitoring program may favor residents with children and thus overlook certain portions

9/7/2001of the community. Residents without children may have higher levels of arsenic and lead in their soils yet not participate in the biomonitoring program and therefore not benefit from the Response Program component of the Community Health Program. If such a property is subsequently sold to a family with children, it is unclear whether the Community Health Program will provide testing to future residents.

Section 5.4

The action level for lead is referred to as 208 mg/Kg. In Section 6.4, it is 207 mg/Kg. Please revise to refer to a consistent number throughout the document.

Tables B-1 and B-2

It does not seem possible that the annual operating and maintenance costs for a Community Health Program of the size and scope of that described in the document could be run for $185,491 annually. Further, the 30-year estimates for the Community Health Program do not factor a rate of inflation into the calculation. Present worth costs do not accurately estimate the true cost of such a program for thirty years out.

Table B-7

The cost estimates presented in Appendix B of the document (Tables B-6 and B-7) for implementation of the plan appear low when considering the scope of services offered and the size of the affected community. An estimate of 250 arsenic and lead tests represents a very low participation rate, which is not consistent with implementing "a very aggressive" biomonitoring program. Also, the cost estimate does not appear to include costs for any paint testing or abatement.

Figure 5-1

The street names on the map are not legible. Please adjust the font size.